AERONAUTICAL ENGINEERING REVIEW

INSTITUTE OF THE AERONAUTICAL SCIENCES

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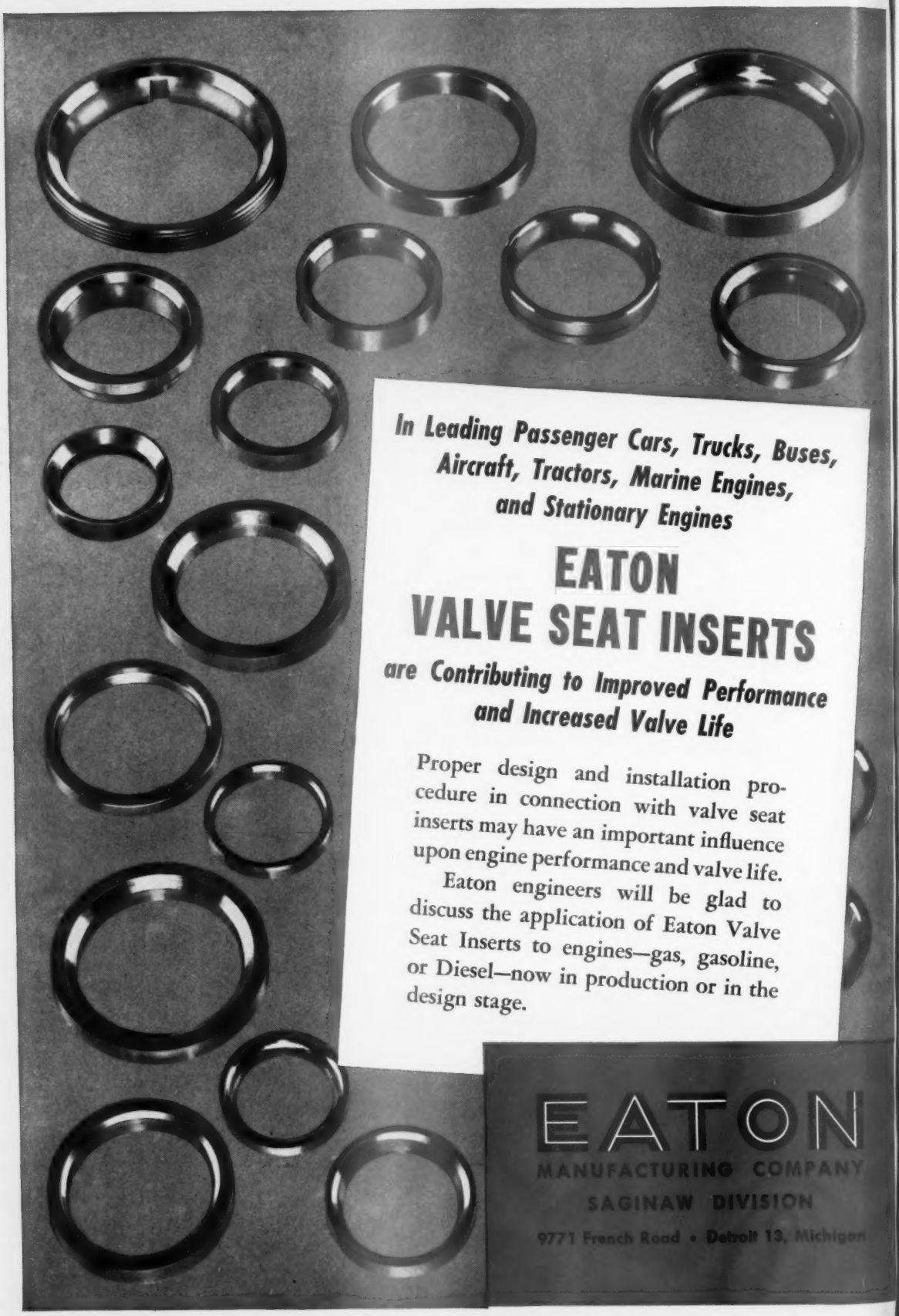

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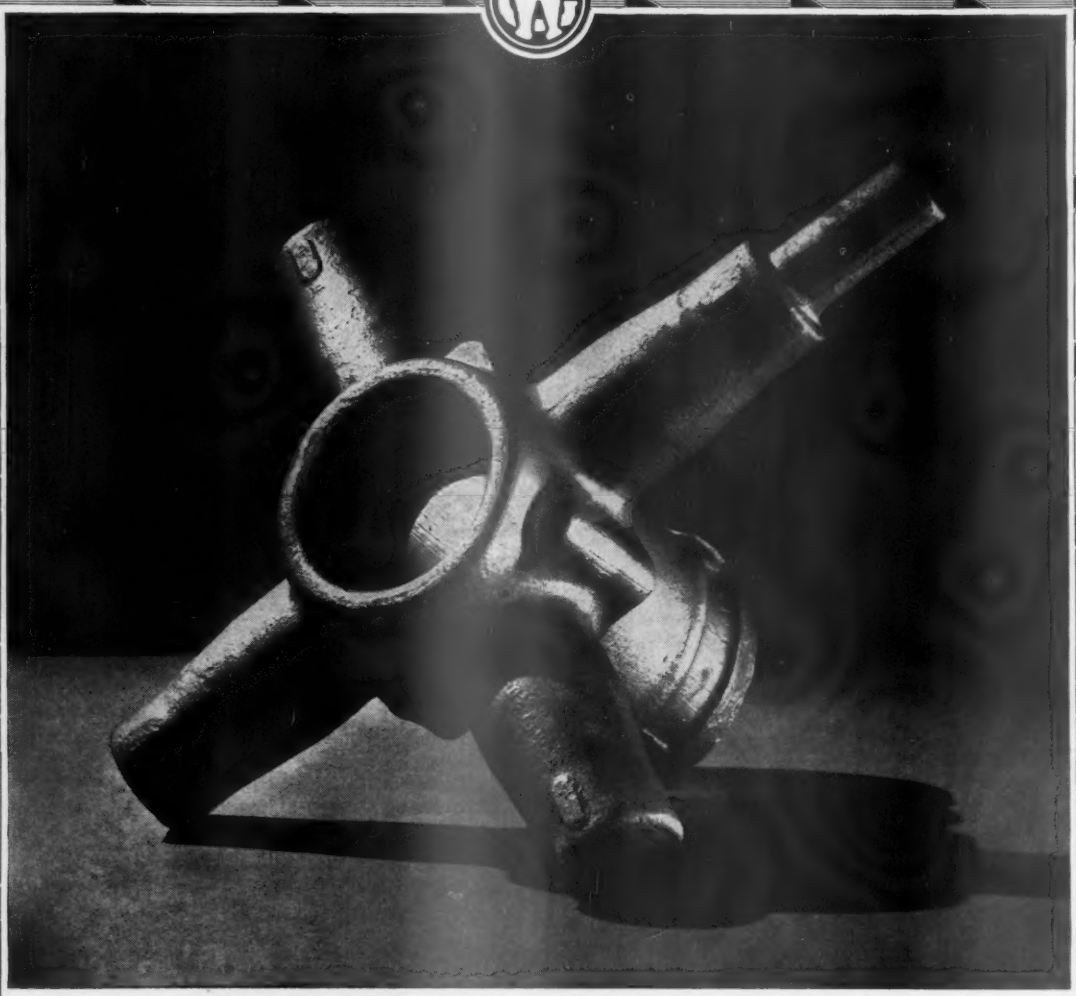

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Cover—The Douglas-built Navy D-558-2 Skyrocket.

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AERONAUTICAL ENGINEERING REVIEW

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ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

I.A.S. News

A Record of People and Events of Interest to Institute Members

16th Annual Meeting Plans Include Air Transport Day

Finletter, Chairman of Air Policy Commission, Guest Speaker at Honors Night Dinner, January 26; Technical Sessions To Be Held Opening Day.

THE INSTITUTE OF THE AERONAUTICAL SCIENCES' big event of the year, the Sixteenth Annual Meeting, to be held in the Hotel Astor, New York City, January 26–29, 1948, will include an Air Transport Day in joint session with the Institute of Navigation.

The Honors Night Dinner, featuring Thomas K. Finletter, Chairman of President Truman's Air Policy Commission, as principal speaker, will follow the opening day of technical sessions, January 26. The Dinner also will be occasion for presentation of the Daniel Guggenheim Medal and top I.A.S. awards including the Sylvanus Albert Reed, Robert M. Losey, Lawrence Sperry, John Jeffries, and Octave Chanute awards.

Vice Admiral Emory S. Land, President of Air Transport Association, is scheduled as chief luncheon speaker on Air Transport Day, January 27.

On Wednesday, January 28, Major Gen. William E. Kepner, Chief, Special Weapons Group, Office of Deputy Chief of Staff for Materiel, U.S.A.F. headquarters, will speak at the luncheon. General Kepner was wartime commander of Eighth Fighter Command until August, 1944, when he was named Commanding General of Second Air Division (heavy bombardment) of the Eighth Air Force. In May, 1945, he assumed command of the Eighth Air Force, succeeding Jimmy Doolittle.

▸**Tentative Program Outlined**—According to plans being formulated as we go to press, a tentative program for the 4-day meeting will include the following technical sessions:

●**Monday, January 26**—Joint session with American Helicopter Society on Rotary Wing Aircraft—three papers have been selected so far. Subjects include testing of rotors for fatigue life, reduction of vibration, and chordwise and beamwise natural frequencies of rotor blades.

In addition, it is planned to include technical sessions on Instruments and Flight Propulsion in the Monday schedule. Subjects planned are—*Instruments:* high-speed flight-research machometers, application of performance operator to aircraft automatic control, and pneumatic method for high gas temperature measuring; *Flight Propulsion:* application of gas turbines to aircraft, method for handling performance of a propeller to a power plant, N.A.C.A. study of gas-turbine blade cooling, and flight-testing America's first gas-turbine propeller.

●**Tuesday, January 27**—Air Transport Day—Joint sessions with Institute of Navigation. Plans call for a symposium on all-weather flying and one on flight handling characteristics.

●**Wednesday, January 28**—Present plans call for a session on aircraft design, beginning in the morning, with remainder of the day devoted to structures. Two papers are scheduled for the former—one on dynamic lateral stability as influenced by mass distribution, and the other a critical study of landing gears—while a symposium on Theory and Practice of Sandwich Construction in Aircraft is planned for the session on Aircraft Structures.

●**Thursday, January 29**—Two sessions are planned to be held jointly with the American Physical Society and will include papers on comparison of methods of calculating span and load distribution on swept wings, supersonic characteristics of triangular wings, boundary layer of yawed infinite wings, and wing body problem in a supersonic conical flow.

Dr. Hugh L. Dryden, Director of Aeronautical Research, N.A.C.A., will be luncheon speaker on Thursday, in addition to being Chairman of the day's sessions.

A complete program, which will contain final revised schedules and titles of papers, the authors, and principal speakers, will be prepared and forwarded to the entire membership by the middle of December.

Thomas K. Finletter, Guest Speaker at I.A.S. Honors Night Dinner.

I.A.S. Calendar

January 26–29	Sixteenth Annual Meeting, New York
March 26	Flight Propulsion Meeting, Cleveland

For details see page 77

I.A.S. Members Fly to Dayton Meeting: *Boarding a T.W.A. Constellation at La Guardia Field, 23 I.A.S. members took off for the Institute's Military Aeronautics Meeting at Wright Field which opened November 17. Group included: William R. Enyart; J. H. Doolittle; J. C. Ward; W. L. Baker; J. G. Borger; G. F. Chapline; R. R. Dexter; S. M. Fairchild; M. B. Gordon; F. H. Hankins, Jr.; B. H. Horchler; R. H. Isaacs; T. Lavelle; C. Mueller; E. D. Osborn; G. B. Post; D. B. Robinson; J. A. Slonim; G. L. Stetson; R. C. Sylvander; F. K. Teichmann; E. E. Aldrin, and L. E. Neville. The meeting, held at Wright Field by invitation of Gen. Joseph T. McNarney, Commanding General, was highlighted by a reception and dinner at Hotel Biltmore arranged by the Dayton Section.*

I.A.S. Meeting In Dayton; Symington Offers "New Deal"

W. STUART SYMINGTON, Secretary of the United States Air Force, guest of honor at the Institute of the Aeronautical Sciences' dinner in Dayton, November 17, laid aside a prepared speech to speak "off the cuff" before an audience composed of some of the nation's foremost aviation leaders, civilian and military, gathered in the Hotel Biltmore.

The occasion followed a day of technical sessions of the Military Aeronautics Meeting held by the Institute at Wright Field by invitation of Gen. Joseph T. McNarney, Commanding General.

▶ **"Too Much Red Tape"**—The new Air Force Secretary told aircraft manufacturers and engineers that there had been "too much red tape in the purchasing end" of Wright Field.

"Wright Field," he said, "will no longer be a consulting byway on an avenue toward getting an order—this is it," adding, "General McNarney is now running Wright Field, period." The general, Symington declared, will "get every ounce of support we have."

Following through with his purpose of putting the Air Force on a business basis, Secretary Symington said he was primarily interested in seeing his program for the new Air Force streamlined into a straight-line business operation. Appealing to the assembled I.A.S. members for support, he stressed the need of teamwork between the Air Force and industry in working out various problems.

Undersecretary for Air, A. M. Barrows, would work closely with Wright Field, the Secretary said, in matters of supply. Barrows' long experience as President of Sears, Roebuck & Company would inject business methods in handling of supply problems.

▶ **Plane Procurement Plans**—Symington revealed that Gen. Carl Spaatz, Air Force Chief of Staff, is asking for 11,000 planes plus 8,100 in reserve and an additional 3,200 to be procured annually. The latter figure would include aircraft for both the Air National Guard and Air Reserve programs.

Speaking of future plans, the Secretary said he regarded the aviation picture as a four-legged stool. "One leg is the Air Force, another the Air National Guard and Air Reserve, a third a healthy air transport industry, and, finally, a strong aircraft manufacturing industry."

The technical sessions preceding the dinner were opened by greetings by General McNarney and remarks by Preston R. Bassett, I.A.S. President; Rear Adm. F. W. Pennoyer, Bureau of Aeronautics representative at Wright Field; and Lt. Col. A. A. Arnhym, Chairman, Dayton Section of I.A.S., and Chairman of the technical sessions of the meeting.

Papers read included:

- Air Force Research and Development Trends—Brig. Gen. A. R. Crawford, Chief, Engineering Division, A.M.C.
- Engineering Planning for Complex Guidance and Control Systems—Col. L. I. Davis, Assistant Chief Engineering Plans, Engineering Division, A.M.C.
- The Current Status of British and American Gas Turbine Development—E. S. Thompson, Manager, Aircraft Gas Turbine Division, General Electric Company.
- Air Force Aero Medical Program—Col. E. J. Kendricks, Chief, Aero Medical Laboratory.
- Development of the Douglas D-558 Project—E. H. Heinemann, Chief Engineer, Douglas Aircraft Company, Inc., El Segundo Plant.

An inspection tour of Wright Field laboratories, where many secrets of Air Force research and development were shown I.A.S. members, featured the second day of the 3-day meeting. The tour covered the Armament, Power Plant, and Aero Medical Laboratories; the Electronic Subdivision building; and the Intelligence Department.

On the final day of the meeting, a paper, "Aircraft Design," was read by C. E. Reichert, Chief, Design Branch, Aircraft Laboratory, A.M.C. In addition, I.A.S. members viewed a static test on the Convair B-36, saw the XB-46 jet bomber, and watched an ejection-seat demonstration.

A reception for visiting Institute members was arranged at the Van Cleve Hotel by the Dayton Section and sponsored by Dayton I.A.S. Corporate Members and Dayton representatives of other Corporate Members.

Transportation of the New York party to the Military Aeronautics meeting at Wright Field was facilitated by Trans World Airline, which added an extra section to its regular flights to and from Dayton.

S.A.I. Conference on Subject Breakdown: *At Standard Aeronautical Index Project headquarters in the Institute of the Aeronautical Sciences in New York, October 24, representatives of the S.A.I. staff met with representatives of Air Documents Division, Air Materiel Command, and Technical Data Division, Navy Bureau of Aeronautics, to complete the first phase of development of the Index. Reading clockwise from left are: Harris F. Reeve, S.A.I. Technical Consultant; Max Sokol, Project Engineer; L. E. Neville, Director; Miss E. Brown, Asst. Librarian; Capt. N. A. Draim, U.S.N., Director, Technical Data Division, BuAer; Lt. Col. A. A. Arnhym, Chief, Air Documents Division, A.M.C.; E. A. Robischon, Technical Consultant, A.D.D.; R. M. Woodham, S.A.I. Administrator; and K. G. Brown, Librarian.*

S.A.I. Completes First Phase; Division Headings Determined

FIRST PHASE OF THE Standard Aeronautical Index development was completed officially October 24 in a conference at the Institute of the Aeronautical Sciences headquarters in New York between representatives of Air Documents Division, Air Materiel Command, Bureau of Aeronautics' Technical Data Division, and the S.A.I. staff.

Representing the Air Force and Navy were: Lt. Col. Albert A. Arnhym, Chief, A.D.D.; Captain N. A. Draim, U.S.N., Director, Technical Data Division, BuAer; and Ernest Robischon, Technical Consultant, A.D.D. The Institute was represented by the headquarters staff of the Standard Aeronautical Index. This project is implemented by a contract with the I.A.S. in which the A.D.D., the Engineering Division, Air Materiel Command, BuAer, and Office of Naval Research participate.

▶ **Determine Subject Breakdown**—Purpose of the conference was to coordinate results of a survey and direct personal contacts made by S.A.I. to determine the major divisional subject breakdown of the entire field of aeronautics on a strictly functional basis.

The survey constituted a poll of the membership of I.A.S. and users of Air Documents Division services. Several thousand questionnaires were sent out, and each recipient was requested to name his specialty in the aviation field.

In addition, a tentative list of Division headings was published for comment in the August 1 and October 1 issues of the *Technical Data Digest*. More than 600 replies and comments were received, tabulated, and organized. On the basis of these replies and several hundred personal contacts, the previously published tentative list of Division headings was modified to represent a true consensus of nearly 1,500 of top specialists in aviation. Headings thus determined are shown in the accompanying box.

▶ **Working on Second Phase**—The S.A.I. staff has been at work for some time on the second phase of the Index program—the further breakdown of the Divisions into Section headings

Standard Aeronautical Index
List of Division Headings

As a result of official action in the October 24 conference at S.A.I.'s New York headquarters, the following alphabetical list of Index Division headings was agreed upon (numbers denote position in numerical arrangement):

Aerodynamics (2)
Air Power (43)
Airplane Design & Description (10)
Airports & Airways (39)
All-Weather Flying (31)
Atomic Energy (48)
Aviation Medicine (19)
Comfortization (23)
Electronics (3)
Equipment, Airborne (14)
Equipment, Electrical (16)
Equipment, Hydraulic & Pneumatic (20)
Flight Testing (13)
Fuels & Lubricants (12)
Gliders & Gliding (35)
Guided Missiles (1)
Hydrodynamics (21)
Installations, Ground (27)
Installations, Shipborne (28)
Installations, Underground (32)
Instruments (9)
Laws & Regulations (44)
Lighter-than-Air (40)
Maintenance (25)
Management & Finance (45)
Materials (8)
Meteorology (30)
Navigation (29)
Operations, Commercial (41)
Operations, Military (24)
Ordnance & Armament (22)
Organizations & Societies (46)
Personal Flying (42)
Personnel (37)
Photography (26)
Power Plants, Jet & Turbine (5)
Power Plants, Reciprocating (6)
Power Plants, Rocket (4)
Production (36)
Propellers (11)
Reference Literature (47)
Rotating Wing Aircraft (34)
Safety & Rescue (15)
Sciences, General (33)
Standards & Specifications (38)
Stress Analysis & Structures (7)
Thermodynamics (18)
Wind Tunnels & Laboratories (17)

Aeronautical Leaders at Dayton Section Meeting Dinner: *Some top leaders in aviation were gathered at the Dayton Section's dinner at the Biltmore Hotel, November 17, following the technical sessions held at Wright Field during the day. Pictured above, left to right (seated): W. Stuart Symington, Secretary of Air Force; Preston R. Bassett, I.A.S. President; and Gen. Joseph T. McNarney, Commanding General, A.M.C. Standing (left to right); S. Paul Johnston, I.A.S. Director; Brig. Gen. A. R. Crawford; A. S. Barrows, Undersecretary of Air Force; Major Gen. B. W. Chidlaw, Deputy Chief, A.M.C.; Lt. Col. A. A. Arnhym, Chairman, Dayton Section; and James H. Doolittle, former Commanding General, Eighth Air Force, now Vice-President of Shell Union Oil Company.*

determined by the way in which each major subject division is practiced, developed, or taught.

This phase of the work is being done largely through personal coordination contacts with specialists in the field. Eastern United States is covered by the headquarters staff; the Middle West by the Dayton representative of S.A.I., and the Pacific Coast territory by members of the staff operating out of the S.A.I. Office at Grand Central Air Terminal, Glendale, Calif., in collaboration with A. B. Deyarmond, Technical Consultant to S.A.I. in San Diego.

After the Section breakdown is determined on a truly functional basis, individual subject headings or cross references will be assigned to each Section of each Division.

▶ **S.A.I. Is Keystone**—Primary purpose of the S.A.I. is to provide a vehicle for the selective high-speed dissemination of abstracts of technical documents by Air Documents Division. The S.A.I. is the keystone of an arch comprising on one side the *Air Technical Index* and on the other the *Technical Data Digest.*

Abstracts of security classified documents are distributed through the A.T.I. under a mass-production processing system at the rate of several hundred a day. Nonclassified technical articles, papers, and other documents are abstracted in the *Technical Data Digest* now being published twice monthly by Air Documents Division.

A unique feature of these abstracts is their timeliness. By special cooperation with publishers and technical and scientific societies, prepublication abstracts are furnished to the *Digest* staff sufficiently ahead of publication so that their appearance in the *Digest* coincides closely with the date of issue in which the full article appears.

Award Lewis, Martin, Kahn N.A.A. Life Memberships

Three members of the Institute of the Aeronautical Sciences, including two Honorary Fellows and Past-Presidents, were presented with Honorary Life Memberships in the National Aeronautic Association during a special dinner October 22 at the Hotel Statler, Washington, D.C., on the occasion of N.A.A.'s 25th anniversary.

The three honored for their contributions to the advancement of aviation were Dr. George W. Lewis, Research Consultant, National Advisory Committee for Aeronautics, a Past-President (1939) and Honorary Fellow of the Institute; Glenn L. Martin, President, The Glenn L. Martin Company, also a Past-President (1936) and Honorary Fellow; and Roger Wolfe Kahn, Manager of Service Department and a Test Pilot with Grumman Aircraft Engineering Corporation, an I.A.S. Member.

More than 50 industry and Government aviation leaders were present.

▶ **Lifetime of Service**—Dr. Lewis, who recently retired as Director of Aeronautical Research for N.A.C.A., has devoted a lifetime of service to the advancement of aviation through technological developments. For 28 years, he recruited and trained N.A.C.A.'s Research Staff, building it up from a handful of workers to its present force of 6,000.

In addition, Dr. Lewis planned and carried through the research facilities at Langley Field, Va.; the Ames Aeronautical Laboratory, Moffett Field, Calif.; and the Flight Propulsion Research Laboratory at Cleveland. He has been a leader in the advancement of aeronautical science both in this country and in the world.

▶ **Aviation Pioneer**—One of the world's outstanding airmen and pioneer in aircraft manufacture and development, Glenn L. Martin was not only honored for his great work in the industry but also for his public-spirited service to education, N.A.A. stressed in making the life membership award.

His company, established in 1909, originally designed dozens of major aircraft developments and processes now in use.

▶ **Private Flying Promoter**—Roger Wolfe Kahn, known for his many years' service to sporting aviation as a timer and official of air races and meets, has also done much to promote private flying. He has been instrumental in reducing red tape and regulations for private pilots and aircraft owners and is a member of numerous aviation organizations dedicated to aviation progress.

New Era Note

Captain Harry J. Marx, U.S.N.R., an Associate Fellow, has returned to civilian life and is President of Van Muffling & Marx Organization, Inc., technical consultants, New York City.

Marx is specializing in the design and construction of atomic bomb shelters and has been devoting considerable time to research and investigation of gamma-ray penetration.

Gifts to the Institute Collections

The U.S. Air Materiel Command added 237 *AAF Technical Reports* and translations and microfilm copies of German documents to its previous generous gifts. Dr. Alexander Klemin gave 87 reports, 22 books, and 103 papers of the Congrés National de l'Aviation Française, 1946. Kurt H. Weil sent 59 books dealing with historical flights and autographed photographs of Juan de la Cierva's autogiro. Photographs and reports dealing with the Custer channel wing airplane were received from the National Aircraft Corporation. Dr. Otto Kallir pre-

sented 41 books, periodicals, and catalogs on air-mail stamps. W. A. M. Burden added current periodicals to his previous generous gifts. The Cornell Aeronautical Laboratory sent 7 technical translations from the German and French, through the courtesy of Miss Elma T. Evans. Periodicals were received from the Eclipse-Pioneer Division of Bendix Aviation Corporation through the courtesy of Miss Mildred M. Baker.

Five scale models of Grumman, Messerschmitt, North American, Republic, and Supermarine fighter aircraft were received from John W. Harder. Paintings by P. Blake of six British civil airplanes were received from Douglas G. Andreoli. Mrs. Bella C. Landauer presented *Flights Over Ancient Cities of Iran*, by Erich F. Schmidt, Chicago, 1940. Eight of its aeronautical reports were received from the College of Aeronautics in Bedfordshire. Omar B. Whitaker sent his early article on "Aeronautical Charts," July, 1917.

Additional gifts were received from The Association of American Railroads, Curtis Publishing Company, The Johns Hopkins University, National Research Council of Canada, Walter Prokosch, Royal Aircraft Establishment, Prof. Maurice Roy, Smithsonian Institution, U.S. Bureau of Aeronautics of the Navy Department, National Bureau of Standards, and Crash Injury Research of the National Research Council.

I.A.S. Newslines

▶ **Colonel Edward E. Aldrin,** Fellow and Member of I.A.S. Council, was appointed Executive Secretary of manufacturing subcommittee of Congressional Aviation Policy Board. Colonel Aldrin, New Jersey's Aviation Commissioner and former Manager of Newark Airport, is on loan to the subcommittee from Atlas Supply Company, Newark. He served with Air Force during the war and holds Air Medal with Oak Leaf Cluster.

▶ **General Henry H. Arnold,** Honorary Fellow, was decorated with China's Order of the Grand Cordon of Yun Hwei, Order of the Cloud and Banner, Special Class, late in October. Presentation was made by Ambassador Dr. V. K. Wellington Koo.

▶ **Preston R. Bassett,** President of Sperry Gyroscope Company, Inc., and President of the Institute, whose firm has been participating jointly with American Museum of Natural History in studying flight of flies, believes the studies may lead to simplification and improvement of the gyroscope. Slow motion pictures reveal fly keeps balance by means of pair of vibrating rods, halteres, protruding from sides of body at wing bases.

▶ **John Nicholas Brown,** Assistant Secretary of Navy for Air, an Honorary Member, revealed that Navy is seeking to perfect "robot brain" that will enable man's faculties to keep pace with speed of mechanized war. Speaking on "Future of U.S. Naval Air Arm" at annual meeting of Aviation Commandery of U.S., Brown said that, because speed of present-day warfare has outstripped man's brain, Navy is working on a "brain machine" that will react faster than a human being.

▶ **Dr. Karl T. Compton,** President, M.I.T. and a Fellow of I.A.S., said cost of universal military program would be $1,750,000,000 a year—one-half of a week's expenditures at peak of World War II.

▶ **Major General L. C. Craigie,** Honorary Member, succeeded Lt. Gen. Curtis E. LeMay as Deputy Chief of Staff for Research and Development.

▶ **Richard H. Depew, Jr.,** Associate Fellow, has joined the Frank Ambrose Aviation Company, Flushing, N.Y., as Director of Sales.

▶ **Donald W. Douglas,** Honorary Fellow and Past-President (1935) of I.A.S., estimated world market, including U.S., for new transports in next 4–6 years at 80–90 four-engined, and 380–400 two-engined planes, in addition to those now on order. By 1950, Douglas said, domestic traffic volume will be about 9,070,000,000 passenger-miles carried in a fleet of 730 planes. This compares with 1946 volume of 6,710,000,000 passenger-miles by a fleet of 723 transports.

▶ **Dr. Hugh L. Dryden,** Director of Aeronautical Research, N.A.C.A., Honorary Fellow and Past-President (1943) of the Institute, declared that research must be organized to provide an independent status with participation in top-level decisions and opportunity to initiate long-range programs. Continuity of leadership is essential, he said, as well as provision for teams of scientific specialists.

▶ **Donnell W. Dutton,** Associate Fellow, is Professor, Daniel Guggenheim School of Aeronautics, Georgia School of Technology.

▶ **Jerome Lederer,** a Fellow, is on National Research Council's Committee on Aviation Psychology. New committee is substitute for former Committee on Selection and Training of Aircraft Pilots, which has conducted research on field of aviation psychology since 1939. Current research program is largely concerned with transport pilots, particularly with human factors in airplane accidents.

▶ **William Henry Miller,** Associate Fellow, has been named Associate Director, Pilotless Aircraft Division, Bureau of Aeronautics, Navy Department.

▶ **Arthur E. Raymond,** Vice-President for Engineering, Douglas Aircraft Company, Inc., a Fellow and Past-President (1946), recommends training of aeronautical engineers be encouraged by N.A.C.A. by provision of more and larger training labs patterned after those set up in eight universities in the 1920's by Guggenheim Foundation. Engineering schools, he said, are suffering an "all-time low of instructors in relationship to students."

▶ **Alfred H. Tiltman** resigned as Director of Fireproof Tanks, Ltd., to become Director, Tiltman Langley Laboratories, Ltd., England. He is an Associate Fellow.

▶ **Dr. Edward P. Warner,** President of ICAO's Council and Honorary Fellow, told American Standards Association at its annual meeting in New York that ICAO is seeking to set world-wide standards without running risk of restricting experiment and development. No material specifications have been adopted, Warner said, because ICAO wants plane manufacturers to remain free to make own choice. A total of 110 pages of airworthiness regulations have been adopted.

▶ **Willis L. Wells,** an Associate Fellow, is now President of George E. Wells, Inc., St. Louis, Mo., product designers and consulting engineers.

Reprints of Anglo-American Conference Papers

All papers presented, together with discussions and proceedings, are being published by the Royal Aeronautical Society. The completed book, containing approximately 750 printed pages, will be available to I.A.S. members in March, 1948. Copies may be ordered in advance from the Institute at $10 for members and $12 for non-members.

Silicone News

DC SILICONES

Silicones Reduce Size and Weight of Totally Enclosed Non-ventilated Motors

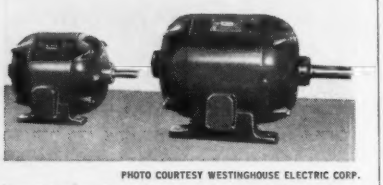


PHOTO COURTESY WESTINGHOUSE ELECTRIC CORP.

New 5 h.p. totally enclosed, non-ventilated Westinghouse motor (at left) protected with Silicone Insulation has same rating as much larger motor (at right) wound with Class A insulation.

This is the kind of industrial news we like to report. It's the story of that new Silicone insulated, totally enclosed, non-ventilated motor made by Westinghouse. This motor weighs only 60% as much as a comparable motor of conventional design. It requires no more space than an open motor of the same rating, and it is comparable in overall performance.

This very significant reduction in size and weight is a result of skillful designing to capitalize upon the exceptional heat stability of the silicone resins and varnishes developed by Dow Corning. These silicone varnishes are not affected by the somewhat higher operating temperatures which are caused by the relatively small radiating surface. The hottest spot temperature rise of this motor is within the 140°C. permissible for this new class of electrical insulation.

This new motor also incorporates another example of progressive engineering in the use of new materials. Its bearings are permanently lubricated with DC 44 Silicone Grease. Consequently, they require no attention for at least five years, in spite of the somewhat higher temperatures at which they operate.

The introduction of this new Silicone insulated motor marks a new era in electrical insulation. The use of Silicone Grease in the bearings marks another major step in the direction of permanent lubrication.

Silicones have been responsible for all sorts of improvements in design and performance, ever since we started to produce them on a commercial scale nearly five years ago. Our experience in putting these new engineering materials to work is at your service. We'll be glad to send you our catalog S 1-6 which describes DC Silicone resins, greases, fluids and Silastic.*

*TRADEMARK FOR DOW CORNING SILICONE RUBBER

DOW CORNING CORPORATION
MIDLAND, MICHIGAN
New York • Chicago • Cleveland • Los Angeles
In Canada: Fiberglas Canada, Ltd., Toronto
In England: Albright and Wilson, Ltd., London

Dow Corning
FIRST IN SILICONES

Corporate Member News

● **Airborne Instruments Laboratory, Inc.,** Mineola, N.Y., has been retained by Air Transport Association as consultants on modification and installation of the large ground surveillance radar equipment to be installed by Pan American at Gander, Newfoundland.

● **American Airlines, Inc.,** reported a net profit of $1,272,514 for third quarter of 1947.

● **American Overseas Airlines, Inc.,** carried 90,405 passengers in 2-year period ending October 23.

● **Beech Aircraft Corporation** has acquired the Government-owned facilities it used during war for $94,000. Beech plans to use additional facilities for manufacture of planes and prefab houses.

● **Boeing Aircraft Company's** hiring program was stepped up in late October—995 workers were taken on in one week—above the 150–200 per week originally planned. Goal is approximately 17,000 total payroll by end of year.

● **Cessna Aircraft Company,** since V-J Day, has produced 6,500 planes.

● **Chance Vought Aircraft Division,** United Aircraft Corporation, was awarded Liberty Mutual Insurance Company's certificate of merit for completing 1,240,518 man-hours without time-loss industrial accident.

● **Eastern Air Lines, Inc.,** has announced expansion of its air-cargo department into six cargo regions.

● **Edo Aircraft Corporation** has changed corporate name to Edo Corporation as a result of its expansion in the electronic field.

● **General Electric Company** has established new Aircraft Gas Turbine divisions to operate plants both at Lynn and Everett, Mass. Facilities for design, testing, and production of jet engines already have been expanded in view of plans to increase production of jet power plants, including new model, details of which are not yet released.

● **Hamilton Standard Propellers Division,** United Aircraft Corporation, has begun 20,000-sq.ft. addition to its East Hartford plant with completion scheduled for next spring. Division is withdrawing machine tools and employees from West Hartford branch. New addition will enable company to complete its postwar reconversion program.

● **Jack & Heintz Precision Industries, Inc.,** elected a new president, Byron C. Foy, succeeding William S. Jack, who resigned for reasons of health.

● **McDonnell Aircraft Corporation** reported a net income after taxes for fiscal year ended June 30 of $540,869.82. . . . .Company won National Safety Council's Aircraft Manufacturing Safety Plaque for year's total of 6,000,000 man-hours, with only 24 hours lost through accidents.

● **North American Aviation, Inc.,** has started construction of new supersonic wind tunnel at the Inglewood plant. New plant is designed to test rocket models at simulated sea-level flight speeds of 1,150 to 3,400 m.p.h.

● **Northrop Aircraft, Inc.,** reported a net profit of $240,573 for fiscal year ended July 31.

● **Northwest Airlines, Inc.,** has been granted an F.C.C. license to operate 59 radiotelegraph public-service aircraft stations, including six portable-mobile stations, aboard its aircraft operating over North Pacific routes.

● **Pan American World Airways System** observed 20th anniversary October 28. Company made its first flight in 1927 between Key West, Fla., and Havana—90-mile route compares with more than 100,000 route-miles covered by Pan Am today.

● **The Parker Appliance Company** has licensed Pacific Screw Products Corporation and Deutsch Company, Los Angeles, to manufacture and sell the "811" flared tube couplings embodying Parker patents.

● **Republic Aviation Corporation** now employs 5,300 people at its Farmingdale, L.I., plant, larger portion of whom are on P-84 production.

● **The Ryan Aeronautical Company** announced appointment of distributors for 1948 model Ryan Navion in six of country's more important aviation market areas. They include: General Aeronautics, Inc., Fort Worth; Mallard Air Service, New York City; Howard Aviation, Inc., Peoria, Ill., Indiana, Wisconsin, and eastern Iowa; Van's Air Service, St. Cloud, Minn., the Dakotas, and northern Wisconsin; St. Louis Flying Service, St. Louis area; and Palo Alto Airport, Inc., in northern California and western Nevada.

● **Solar Aircraft Company,** San Diego, has opened new office at Stoneleigh Court, Room 106, 1025 Connecticut Ave., N.W., Washington, D.C. . . . .Company's Des Moines plant is in push-button coffee brewing accessory business for a Chicago coffee-making device firm.

● **Thompson Products, Inc.,** with sales running at a rate indicating the $100,000,000 figure will be reached this year, announced sizable expansion in third quarter earnings. Net for full year is placed between $8.00–9.00 per share, against $2.71 shown on the common in 1946.

● **United Air Lines, Inc.,** for second time in 3 years, has been awarded a bronze "Oscar of Industry" trophy at New York for best annual report, according to survey by *Financial World Magazine.* United received similar award in 1944.

● **Western Airlines, Inc.,** has completed a reorganization and streamlining of its traffic and advertising department to provide for straight-line administrative setup and at same time delegate more authority to field personnel.

Sections and Branches

Dayton Section

E. W. Robischon, *Secretary*

The Section, holding its monthly meeting October 17, unanimously re-elected its present officers at a brief business session. Lieutenant Colonel A. A. Arnhym, Chairman, appointed Lt. Comdr. H. J. Huester, A. F. Arcier, and Ezra Kotcher, in addition to Section officers, as members of the Dayton Section Council.

Speaker of the evening, William B. Stout, Consultant, Research Division, Consolidated Vultee Aircraft Corporation, presented his paper, "A New Approach to the Flying Problem," at the Technical Session attended by approximately 100 members and guests.

▶ **"Flapping Wing"**—Stout's paper, illustrated by slides and motion pictures, covered the development of a flapping wing device based upon insect flight principles. In addition, the speaker demonstrated the principles of the flapping wing by means of a flying model.

Philadelphia Section

John Rogers, *Secretary*

A meeting of the Executive Committee was held September 12 at the home of F. G. Tatnall. Meeting was called to review plans for a total of six meetings for the 1947–1948 season.

At the September 30 session, Capt. J. R. Poppen (M.C.), U.S.N., Superintendent of the Aeronautical Medical Equipment Laboratory at the Naval Air Experimental Station, Philadelphia, spoke on "The Flight Surgeon Looks at Current Aeronautical Science."

▶ **Problems of Safety**—Some of the past attitudes and approaches of the Flight Surgeon to the problems of safety in flight and how methods have changed were discussed by Captain Poppen. Presenting the challenges before the Flight Surgeon in combating adverse physiological effects of flight at very high altitude, flight in the transonic and supersonic speed ranges, high acceleration maneuvers, flight through radioactive clouds, etc., Captain Poppen discussed methods and techniques being used to provide protection for flight personnel.

▶ **Protection Methods Used**—These methods of protection included anti-*g* suits, pressurization, and seat ejection. Captain Poppen's talk also covered present and future problems, the approach to their solutions, and what the engineer can do to aid the work of the Flight Surgeon.

The Section's October 30 meeting heard Arthur M. Young, Designer, Bell Aircraft Corporation, on the subject of "Organization for Helicopter Design."

▶ **Paramount Problem**—Young believes one of the paramount problems facing rotary-wing aircraft manufacturers is that of accommodating the helicopter to the public. A basic design, according to Young, can be developed by engineering, can be manufactured, and then made ready for public acceptance. From this point, innumerable changes begin for the manufacturer.

The helicopter will be used for many functions not contemplated in the first designs. Also, various structural parts are subjected to severe tests in widely different weather conditions and in places with different surface conditions, such as sand, grass, gravel, and weeds. Many examples were cited of design changes made to meet these varying conditions of weather and ground.

▶ **Organization Chart**—In order to deal with design changes, most problems of which originate in the field, Young advocates an organization chart similar to a wheel by which a design problem would travel directly to the control center rather than progress through the complicated steps to the various departments concerned, as in the typical chain type of chart.

Young believes that, if the graphic movement of the chart has greater horizontal and less vertical action, considerable time will be saved and greater service rendered to the public.

Calendar

I.A.S. Section Meetings

DETROIT—JAN. 13
Engineering Society of Detroit
"Atomic Energy for Aircraft Propulsion"

PHILADELPHIA—JAN. 14
Engineers Club
Information Please Night

WICHITA—JAN. 6
Drolls English Grill
Speaker: D. S. Lewis
"Development of High-Speed Jet Aircraft"

Skyrocket Details

Design details and engineering problems of the Navy-Douglas D-558 Project, including the famous Skystreak and newly announced Skyrocket, were given recently by Edward H. Heinemann, Chief Engineer, Douglas Aircraft Company, Inc., El Segundo Plant, at the New York Section's first meeting of the 1947–1948 season.

Mr. Heinemann, who has been responsible for the development of the D-558 Project, discussed all phases of the Skystreak's design considerations and included details of the D-558-2, a development of the Skystreak design.

See article on page 14.

San Francisco Section

Don O. Horning, *Secretary*

Meeting in Red Wood City, October 9, members heard Frank W. Fink, Chief Engineer, Airline & Military Airplanes, Consolidated Vultee Aircraft Corporation, who presented his paper: "Design Development of the Convair Liner."

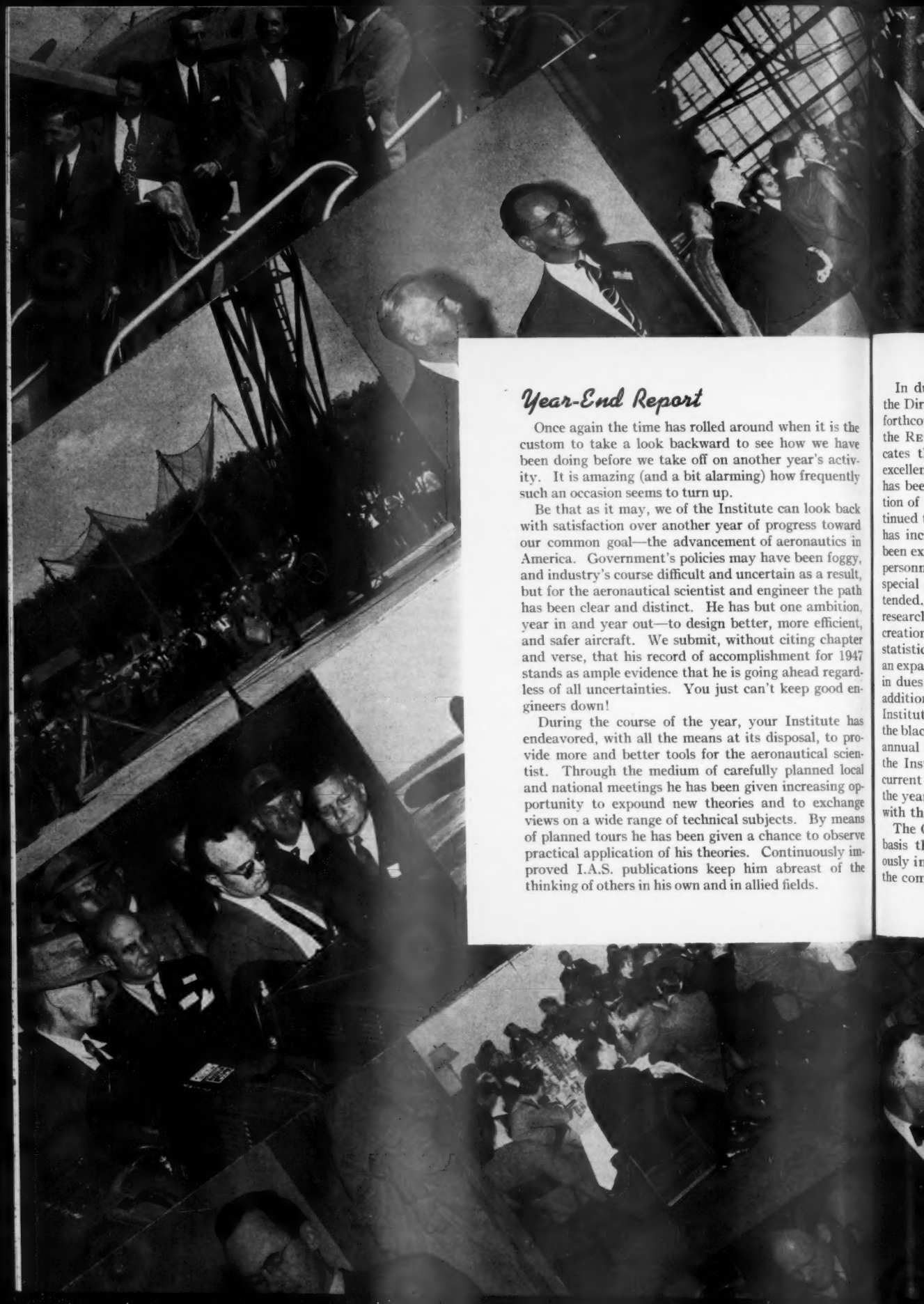
In addition to Fink's paper, which was illustrated by motion pictures of the Convair Liner in operation, there was a short film of the XB-46, showing the jet bomber's taxi run and first flight. *Aircraft Oddities*, another short film, also was shown.

▶ **Design Background**—In his paper, Fink traced briefly the development of the first Convair design for a postwar two-engined transport, a design resulting from an Air Transport Association committee specification written in 1943.

The first design, consisting of a high wing and rather square fuselage, held 28 passengers. This design was dropped in favor of a low-wing type with more streamlined fuselage and higher performance, following contacts with air lines later, and, by June, 1945, the preliminary design had progressed from drawing board to experimental model, known as the Convair Model 110.

This airplane was announced to the air lines at an A.T.A. conference in Denver in August, 1945, and was engi-

(*Continued on page 71*)



Year-End Report

Once again the time has rolled around when it is the custom to take a look backward to see how we have been doing before we take off on another year's activity. It is amazing (and a bit alarming) how frequently such an occasion seems to turn up.

Be that as it may, we of the Institute can look back with satisfaction over another year of progress toward our common goal—the advancement of aeronautics in America. Government's policies may have been foggy, and industry's course difficult and uncertain as a result, but for the aeronautical scientist and engineer the path has been clear and distinct. He has but one ambition, year in and year out—to design better, more efficient, and safer aircraft. We submit, without citing chapter and verse, that his record of accomplishment for 1947 stands as ample evidence that he is going ahead regardless of all uncertainties. You just can't keep good engineers down!

During the course of the year, your Institute has endeavored, with all the means at its disposal, to provide more and better tools for the aeronautical scientist. Through the medium of carefully planned local and national meetings he has been given increasing opportunity to expound new theories and to exchange views on a wide range of technical subjects. By means of planned tours he has been given a chance to observe practical application of his theories. Continuously improved I.A.S. publications keep him abreast of the thinking of others in his own and in allied fields.

In due course, the formal reports of the President, the Director, and the Treasurer will be presented at the forthcoming Annual Meeting and published in full in the REVIEW. Meanwhile, a preliminary reading indicates that your Institute came through the year in excellent condition. The quality of our membership has been maintained. In spite of widespread contraction of the aviation industry, our membership has continued to grow. The number of Sections and Branches has increased. The coverage of our publications has been expanded. The services rendered by our libraries, personnel placement and membership departments, special publications, and other divisions have been extended. In addition, we have undertaken an important research project for the Air Force and the Navy—the creation of the Standard Aeronautical Index. One final statistic, but perhaps the most important: In spite of an expanding scale of activity, and without any increase in dues to the individual member or any requests for additional funds from our corporate membership, the Institute wound up its fiscal year on September 30 "in the black." The margin was not great ($375.33) but our annual audit indicates that the normal operations of the Institute were carried on within the limits of our current income, which was your management's target for the year. The budget for fiscal 1948 has been drawn up with the same objective.

The Officers and Council are confident that on that basis the Institute will be able to render a continuously improving service to its membership throughout the coming year.

S. P. J

The Development of the Navy-Douglas Model D-558 Research Project*

E. H. HEINEMANN

Chief Engineer
Douglas Aircraft Company, Inc.

Purpose of Project

During the latter part of 1944 it became apparent to the Navy Department, the National Advisory Committee for Aeronautics, and the Douglas Aircraft Company that some form of large-scale flight-test research was necessary to obtain aerodynamic data required for the efficient and safe design of future high-speed aircraft approaching the speed of sound. Various methods were considered, such as free drops of streamlined shapes from high altitudes, large-scale supersonic wind tunnels, pilotless remotely controlled aircraft, and inhabited aircraft. Of all these methods, the inhabited aircraft appeared to be the quickest and most practicable. As a result, the Douglas D-558 research project was originated. The wisdom of this choice has since been proved.

The project involves principally three agencies. The Navy Department handles the general administration and provides the appropriations. The N.A.C.A. supplies consulting services, conducts some of the wind-tunnel tests, provides test instrumentation, and will coordinate and conduct the research phase of the flight-test program. The Douglas company's responsibility is the design, construction, and testing of the airplanes for satisfactory flying qualities.

It was decided early in the program that, in order to obtain the maximum usefulness of this program, it would be necessary to establish the following design requirements:

(1) The project should be unencumbered by military requirements for armament, radar, arresting gear, etc.

(2) The airplanes must be capable of taking off and landing under their own power and have satisfactory low-speed characteristics in order that the knowledge gained can be directly applied to subsequent combat types.

(3) The airplanes should be capable of carrying a pilot and approximately 500 lbs. of load-measuring instrumentation for an endurance sufficient for stabilized flight.

(4) The airplanes should have the maximum speed attainable with available power plants.

The project consists of two distinct airplanes: the first, the model D-558 turbojet-powered Skystreak; the second, the model D-558-2 turbojet- and rocket-powered Skyrocket.

The Skystreak was first conceived in the early part of 1945. Twenty-three months were required from au-

* Presented at I.A.S. New York Section Meeting, November 21, 1947.

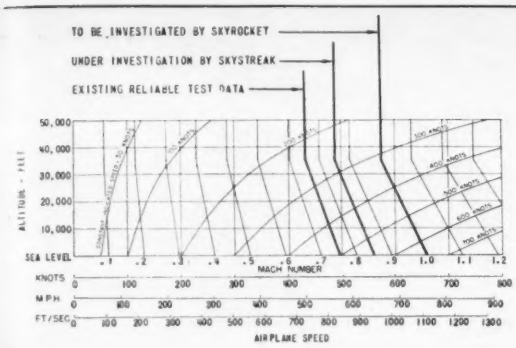


Chart showing speed and altitude region for which the aerodynamic conditions are presently known, the region being surveyed by the Douglas Skystreak and the region to be investigated by the new Douglas Skyrocket.

FIG. 1.

thorization to first flight. The D-558-2 Skyrocket was conceived in the latter part of 1945 when it became apparent that new aerodynamic and power-plant developments would make it possible to take another substantial step beyond the D-558 Skystreak.

RESEARCH PROGRAM

After the usual contractual demonstration and airworthiness tests, the airplanes will be turned over to the N.A.C.A. by the Navy Department for the research program. During this phase each model will be flown to its limiting speed at various altitudes, during which air-pressure distribution over the wing and tail surfaces, as well as control forces, will be measured.

Fig. 1 illustrates that the Skystreak will investigate the region between approximately a Mach Number of 0.75 and 0.85 from sea level to approximately 40,000 ft., a region in which there is little, if any, reliable test data in existence.

The Skyrocket, because of its swept wings and rocket power, will investigate the region from approximately a Mach Number of 0.85 to 1 and to a somewhat higher altitude.

It is anticipated that the instrumentation provided will indicate, between successive flights, the variation in trends in air loads and forces in such a manner that limiting conditions can be anticipated and approached with relative safety.

Although tests will be made at various altitudes and conditions of flight, a typical test run of the research program for the Skystreak will be, for example, to take off and climb to the desired altitude, fly in level flight with flight recorder in operation until stabilization has been reached, then return to the base, at all times under its own control and power. The average flight will be about 30 min. in duration.

In the case of the Skyrocket, a typical test run will consist of a take-off and climb to the desired altitude with turbojet only in operation, a high-speed level flight run of about 2 min. duration with rocket motors, then the return to the base and landing with the turbojet. The whole operation again will take only about 30 min. During the few minutes the rocket motor is operating, 1.5 tons of rocket fuel are burned. The exact rate of consumption depends upon the nature of the particular test and the method of firing the rocket motor chosen by the pilot.

DESCRIPTION OF AIRPLANES

To reduce risks and unknowns to a minimum, it was considered advisable to keep both the Skystreak and Skyrocket as conventional in arrangement as possible.

The Skystreak

The Skystreak has a low-wing, conventional tail arrangement with a nose-wheel landing gear and is powered by a TG-180 turbojet engine, the most powerful engine available. Particular care was taken to locate the horizontal tail high on the vertical tail in order to reduce wing influence at high speed to a minimum. There is no sweepback employed in either the wing or the tail.

The fuselage is a body of revolution housing the pilot, instrument compartment, and engine. The landing gear retracts into the wing.

Because of lack of space within the airplane, the 20 by 4.4 wheels of the Skystreak were especially designed and built by The B. F. Goodrich Company. The 8-ply, nylon tires, originally intended to operate at 230 lbs. per sq. in., are now operating satisfactorily at 175 lbs. per sq. in. It was realized from the outset that this wheel and tire size was much smaller than desired for the load, but the selection was considered justified because of the serious effect larger wheels would have had upon the size of the airplane.

Two-hundred and thirty gallons of kerosene-type fuel are carried in the forward 50 per cent of the wing that is made fuel-tight by sealing with a Stoner-Mudge process. This process consists of a synthetic rubber coat-

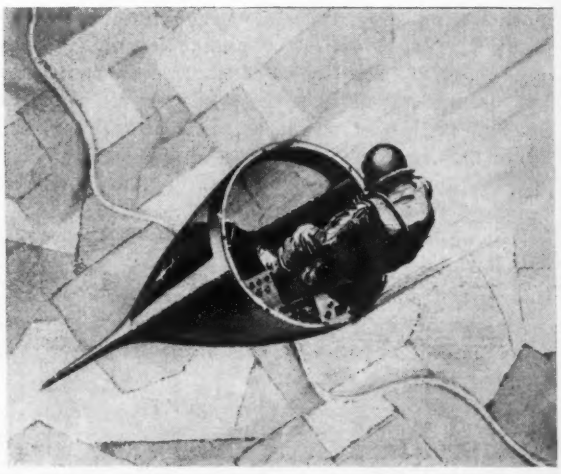


FIG. 2. Emergency exit.

ing applied to the entire interior of the wing. Although complex and lengthy, requiring about 5 weeks per wing to apply and cure, this process has been found to be satisfactory for this purpose.

Auxiliary wing-tip tanks are provided to increase the endurance by approximately $^1/_2$ hour. To avoid any damage to the wing tip or aileron during jettisoning, the tanks are positively ejected by means of a powder charge.

Consultation with aeromedical experts indicated that it was doubtful that a human being could survive a normal bail-out from this airplane at high speed. A jettisonable seat was investigated, but the accelerations required to throw the pilot clear of the vertical tail were in excess of human anatomical limits. It was, therefore, concluded that the only safe method of bailing out at high speed would be to jettison the cockpit, as shown in Fig. 2. A release mechanism, similar to a bomb rack in principle, is provided at four points to release the cockpit from the main portion of the fuselage, with a second release mechansim provided to release the pilot's seat back after the nose portion of the fuselage has slowed down considerably to permit a safe bail-out. Normal low-speed bail-out provisions are also incorporated.

The Skyrocket

The Skyrocket, being a more recent development, employs sweptback wings and, in addition to a Westinghouse 24C (J-34) turbojet engine used for take-off, climb, and landing, a rocket power plant built by Reaction Motors, Inc., for high-speed operations.

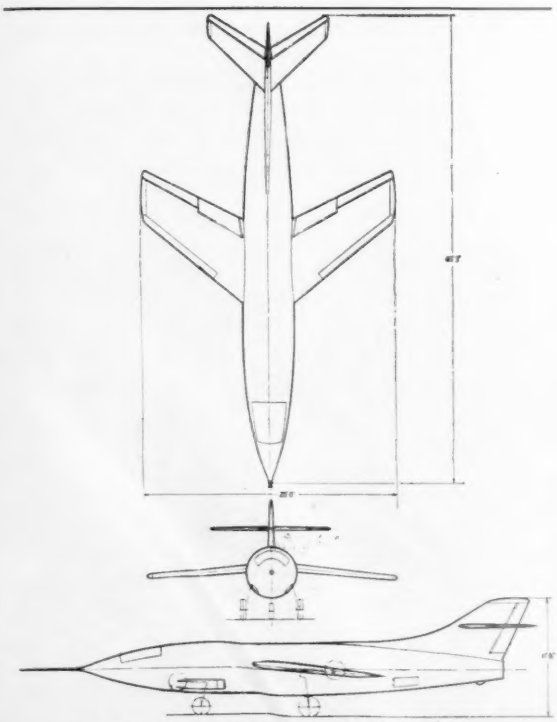


FIG. 3. Douglas D-558-2 Skyrocket—three views.

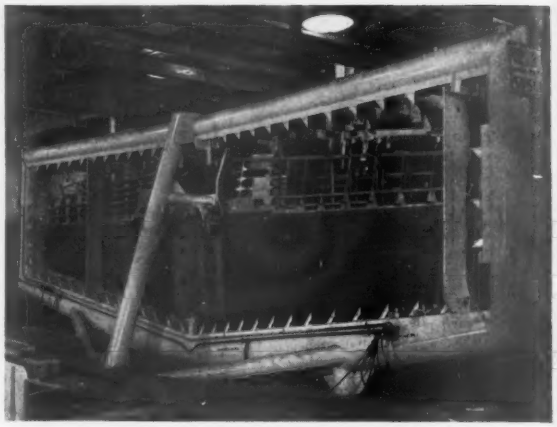


FIG. 4. Typical structure jig.

The landing gear of the Skyrocket is housed in the fuselage because there was insufficient space in the wings. All fuel and propellants, the rocket motor, and the turbojet are also housed in the fuselage. Tankage for 250 gal. of aviation gasoline—not kerosene—is provided for the turbojet engine in addition to special rocket propellants.

From experience with the Skystreak it appears that one of the most interesting features to the public is its bright red finish. The Skyrocket was also scheduled originally to be painted red (the standard color for identifying experimental airplanes), but its color was changed recently to white. Although tests have proved white to be visible at a far greater distance than red, it may prove confusing because of its similarity to the light gray used on Army jet fighters. As a consequence, although the Skyrocket is at present painted white, its color may be changed at any time to suit conditions.

STRUCTURE

The wing and tail surfaces of both models are of relatively conventional rib and stringer-type construction. High-strength 75S aluminum alloy was used almost entirely for the construction of these surfaces. The fuselages of both the Skystreak and Skyrocket consist of a semimonocoque structure using aluminum-alloy frames and heavy magnesium-alloy skin without stiffeners. The average skin thickness is approximately 0.1 in. The principal reasons for selecting this fuselage construction were increased usable space in the fuselage due to the absence of stringers, smoother external surface resulting from use of heavy gage skin and machine countersunk rivets, and a weight-saving of approximately 60 lbs. in the fuselage of the Skystreak. The use of magnesium skin in the Skyrocket resulted in no weight-saving, since the radius-thickness ratio was less favorable than for the Skystreak.

The extensive use of magnesium with its hot-forming technique proved entirely satisfactory and is believed practicable for production. It remains to be seen, however, whether satisfactory service life and corrosion characteristics can be expected.

Another point of interest in the structure is the use of tungsten-alloy counterweights on the ailerons. These were employed because the wing had insufficient space for the accommodation of conventional lead balance weights. The tail surfaces had insufficient space for internal balance weights even using tungsten alloy, with the result that external balance weights were necessary.

To obtain the best possible surface smoothness, very rigid jigs were constructed in a manner to permit building from the skin inward. By fitting the fuselage and wing skins to metal contour forms and then assembling the internal structure to the skin, surface irregularities were kept to a practicable minimum.

Controls

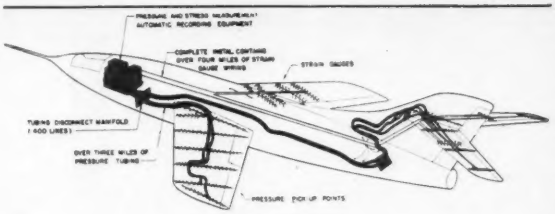
All flight controls are manually operated without benefit of aerodynamic balance, power boost, or tabs. The horizontal stabilizers are adjustable in flight by means of electric actuators operated by a switch on the control wheel. To minimize possibility of flutter or "buzz," hydraulic dampers were provided for all control surfaces.

Cockpit Temperatures

Heating and refrigeration provisions were made for the cockpits of both models. Without the use of refrigeration it is estimated that the temperature in the cockpit of the Skystreak during its record-breaking flights would have reached approximately 178°F. With refrigeration, however, it was possible to keep the cockpit temperature in the neighborhood of 100° to 115° F. No actual measurements were made. The performance of the refrigeration system is truly remarkable, considering that cabin pressure air is taken from the engine compressor at approximately 450°F. and cooled to approximately 60°F. before it is discharged into the cockpit.

Instrumentation

In addition to conventional pilot's instruments, three basic types of recording instruments have been developed. A photographic flight recorder was developed by Douglas to record, on motion-picture film, the readings of a battery of flight instruments. This system is being used during first flights and contractual demonstrations. A pressure-measuring system, consisting of automatically recording manometers, has been developed by the N.A.C.A. to measure air pressures at 400 orifices on the wing and tail surfaces. Control forces and stresses in the airplane structure are measured by means


PRESSURE AND STRESS MEASUREMENT AUTOMATIC RECORDING EQUIPMENT
COMPLETE METAL COATING OVER FOUR MILES OF STRAIN GAUGE WIRING
STRAIN GAUGES
TUBING DISCONNECT MANIFOLD (400 LINES)
OVER THREE MILES OF PRESSURE TUBING
PRESSURE PICK-UP POINTS

DOUGLAS D-558-2 SKYROCKET

INSTRUMENTATION DIAGRAM SHOWING STRESS MEASURING STRAIN GAUGES AND PRESSURE MEASURING ORIFICES

FIG. 5.

of strain gages and are automatically recorded on sensitized paper by an oscillograph.

In the case of the Skystreak it was possible to isolate the fuselage from the wing (Fig. 6) by means of statically determinate links equipped with strain gages in a manner that permits measuring the forces on the wing with a minimum number of strain gages. This was impracticable with the Skyrocket because of congestion in the fuselage, and it was therefore necessary to provide a larger number of strain gages in the wing and tail surface structures. A total of 904 separate strain gages recording on 226 channels or at 226 points are used on the Skyrocket.

Since these airplanes are essentially measuring devices, a great deal of care was given the serviceability and utility of the instrumentation. All strain-gage wiring and pressure tubing terminate in manifolds in the instrument compartment in order to permit rapid replacement or interchange of the various pieces of equipment.

A typical orifice consists of a standard countersunk head Rivnut inserted from the exterior of the skin and secured to an aluminum-alloy tube fitting on the interior of the wing or tail surfaces. An "O" ring prevents leakage at the juncture of the fitting to the skin. This type of orifice has proved serviceable even when submerged in the fuel tank of the Skystreak.

Fig. 7 illustrates a typical oscillograph flight record and calibration. The great difficulty in separating one trace from another is shown by this record. In the event it becomes necessary, a method of color separation has been worked out as shown by Fig. 8. This system, however, has the disadvantage of additional cost and increased film thickness, which results in about one-half the film capacity possible with the black-and-white sensitized paper.

Unusual care was taken to ensure the proper operation under all simulated flight conditions prior to the installation of the instrumentation in the airplanes. In addition to vibration tests, the recording instrument assemblies were tested for acceleration to 12*g* in a centrifuge at the University of Southern California.

Speed Records

At the time the D-558 was begun, it had probably not occurred to any of the persons responsible that it would establish several new speed records. It so happened,

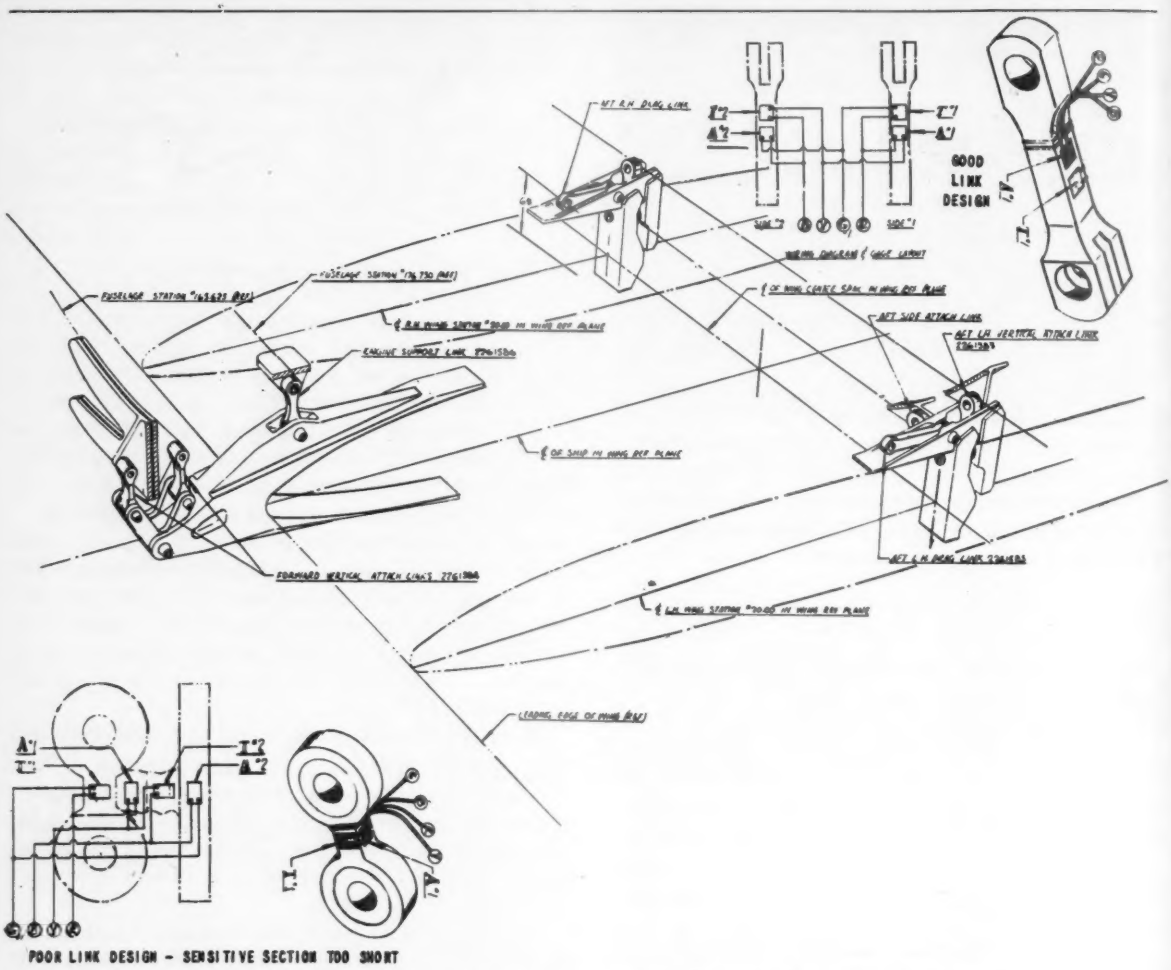


FIG. 6. Wing link system used to measure forces between wing and fuselage.

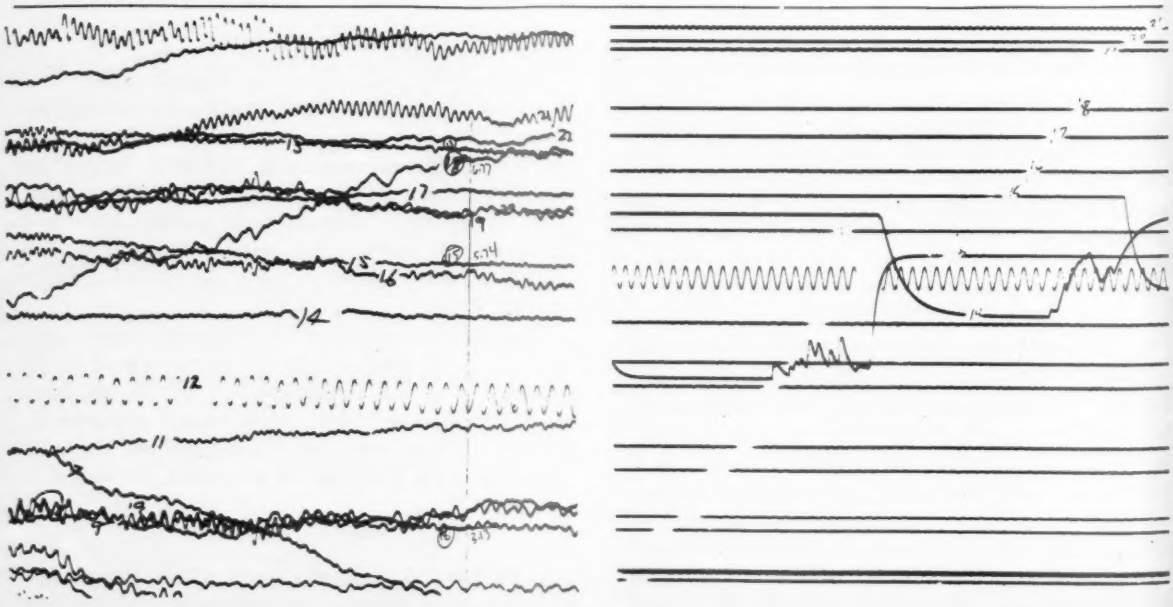


FIG. 7. Typical calibration and flight record.

however, that the summer of 1947 found the Skystreak operating satisfactorily at speeds in the neighborhood of the world's speed record. At the first suggestion of breaking the record, careful thought was given to the pros and cons, and a conclusion was reached that there should be no great risk or delay in the program by making the record flights.

It was believed that desirable calibration of instrumentation might be obtained in making the speed trials, and, in addition, the trials would demonstrate that skilled pilots are able to fly at such speeds close to the ground with complete stability and control. The data thus obtained from the speed-record portion of the program more than justified the record flights. Rather than a delay in the test program as feared by some, the speed-record flights had an accelerating influence on the entire program.

It was particularly gratifying that after less than 10 hours flying time on the first airplane, a new world's speed record was established by Comdr. Turner Caldwell on August 20, 1947, of 640.7 m.p.h. Only 5 days later a second record was established by Marine Corps pilot Major Marion Carl of 650.6 m.p.h. These record runs were made at the U.S. Army Air Test Center at Muroc, Calif. The same Mach Number was reached by each pilot because of the difference in temperature on the different days.

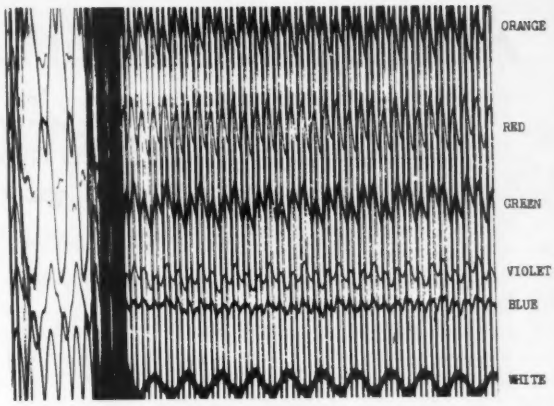


FIG. 8. Color trace identification.

CONCLUSION

In conclusion it is believed that the project can at this time be considered highly successful. Many valuable lessons in the design and construction of high-speed airplanes have been learned with this project by the Navy, the N.A.C.A. and the industry, and it is expected that the data obtained from the N.A.C.A. research program will result in more efficient and safer designs of high-speed airplanes in the future.

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Analysis for Optimum Transport Airplane Configuration

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ABSTRACT

A generalized study determines the sizes, types, and utility of cargo airplanes designed for cruising speeds from 325 to 475 m.p.h., for pay loads from 20,000 to 100,000 lbs., and for ranges of 1,500 and 3,000 miles. It is shown that the turbine-jet engine is superior for the highest speed, short-range operation for any pay load. The turbine-propeller engine is superior for all other conditions. A pay load of 100,000 lbs. cannot be carried 3,000 miles at 475 m.p.h. with engines that will be available in the near future.

Comparing the utility of the airplanes derived, the small pay-load airplane is the most efficient in the work done per unit cost. However, although the efficiency of the small pay-load airplane reduced with increased speed, airplanes designed to carry the larger pay loads have an optimum efficiency at the highest speeds. A small pay-load, fast airplane is as efficient as a large pay-load, slow airplane. Choice of other parameters result in other conclusions.

NOMENCLATURE

A_N	=	nacelle frontal area
A_F	=	fuselage frontal area
A_{NF}	=	nacelle plus fuselage frontal area
B	=	ratio of equipped empty to initial gross weight
P	=	pay load
S	=	wing area
T	=	take-off thrust
V_T	=	initial true air speed
W_0	=	initial gross weight
W_F	=	final gross weight
W_3	=	fuselage weight
W_4	=	wing plus tail weight
W_5	=	landing gear, controls, hydraulic, electrical, anti-icing and unusable fuel and oil weight
W_6	=	crew weight
W_7	=	furnishings, air conditioning, and equipment weight
W_8	=	power-plant weight
L/D	=	lift/drag ratio
b.h.p.	=	take-off brake horsepower
c	=	specific fuel consumption based on power
d	=	average fuselage diameter
f	=	specific fuel consumption based on thrust
l	=	fuselage length
C_L	=	lift coefficient
η	=	propeller efficiency
ρ	=	air density

INTRODUCTION

THE OBJECT OF THIS ANALYSIS is to present a table of airplanes, logically derived from a general study, to perform typical cargo transport jobs. The intent is to show the effect of three variables—namely, range, pay load, and cruising speed—on the size, type, utility, and economy of cargo airplane designs. The variables chosen are: range, 1,500 and 3,000 miles; pay load, 20,000, 50,000, and 100,000 lbs.; speed, 325, 400, and 475 m.p.h.

The type of airplane considered is one designed specifically for cargo transport. The choice of power plant is not immediately obvious, and, therefore, the following three types are compared: turbosupercharged reciprocating-type engine; turbine-propeller-type engine; and turbine-jet-type engines.

An analysis of this type may be attacked by one of two methods: (1) by layout and analysis of many airplane designs, each continued to the point where optimum configurations are derived and all assumptions of performance and weight are verified; and (2) by simplifications based on assumptions, derived from education and experience, substituted into algebraic formulas.

The latter method is used herein because of the scope of the data desired. However, every empirical assumption has been based on current experience and is believed to be valid for conventional design. Considerations are limited to conventional airplanes, because this is a reanalysis of trends in current progress and is not intended to enter into arguments on unconventional airplane configurations. Many authors in the past have prognosticated limitations of aircraft growth. This is a similar extrapolation into future capabilities in design based on the best engineering information currently available.

ASSUMPTIONS

(1) The airplane is considered only as a design for the transport of cargo. Internal volume for a unit weight of cargo is maintained following current practice for desired cargo density, evidenced by modern airplane designs.

(2) The engines and their power, size, weight, and fuel consumption characteristics are based on current practice and do not depend on future developments, even though such developments are currently envisioned. This is both necessary because of restrictions on use of projected design information and desirable to indicate the limitations that available engine characteristics impose on the airplane.

(3) The airplane configuration is conventional, with wing, fuselage, and tail. Wing aspect ratio, wing loading, and relative tail length and area are held constant at values that are chosen as typical.

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(4) Aerodynamic characteristics, particularly the ratio of lift to drag of wing plus tail and the proper drag values for fuselages and nacelles, are chosen at values that are presently attainable by careful design.

(5) Flight safety is considered by the expedient of maintaining a favorable value of the product of wing loading times power loading. It is assumed that equivalent maximum airplane lift and propulsive efficiency will be realized for all resulting designs. Thus, equal take-off distances are maintained.

(6) Because high-altitude flight is desirable for many reasons, such as increased speed, regularity of operation, etc., all aircraft are designed for cruising flight at 30,000 ft. This is to the benefit of the turbine engine, but the disadvantage to the reciprocating engine is slight and only appears in a small additional airplane empty weight to include a cruising-type turbosupercharger and its cooling components.

Aerodynamic Data

This analysis is based upon two exact formulas for range, into which average values of the pertinent parameters are substituted. The formulas and parameters are discussed in the following:

(1) For reciprocating and turbine-propeller engines, the standard Breguet Range formula is used:

$$\text{range} = 863.5\ (\eta/c)(L/D)\ \log_{10}\ (W_0/W_F)$$

where

η = propulsive efficiency assumed at 85 per cent for all speeds. Present developments in propellers and propeller-spinner design combinations indicate that this high efficiency may be maintained to a speed of 475 m.p.h. by careful design.

c = specific fuel plus oil consumption. For reciprocating engines, a fuel-to-oil ratio of 30 to 1 by volume is assumed. Basing conditions on a cruising altitude of 30,000 ft., turbosupercharged, a value of c = 0.47 lb. per b.h.p.-hr. appears reasonable with current engine design. The turbine-propeller engine is also assumed to fly at 30,000 ft. Specific fuel consumption on these engines are a function of air speed, both because of the effects of ram pressure ratio and because jet thrust is an important component. Current design information indicates that the values listed below are applicable, although it is apparent that these can be materially improved upon in the future.

V_T = 325 m.p.h.
= 400 m.p.h.
= 475 m.p.h.

c = 0.528 lb. per b.h.p.-hr.
= 0.510 lb. per b.h.p.-hr.
= 0.492 lb. per b.h.p.-hr.

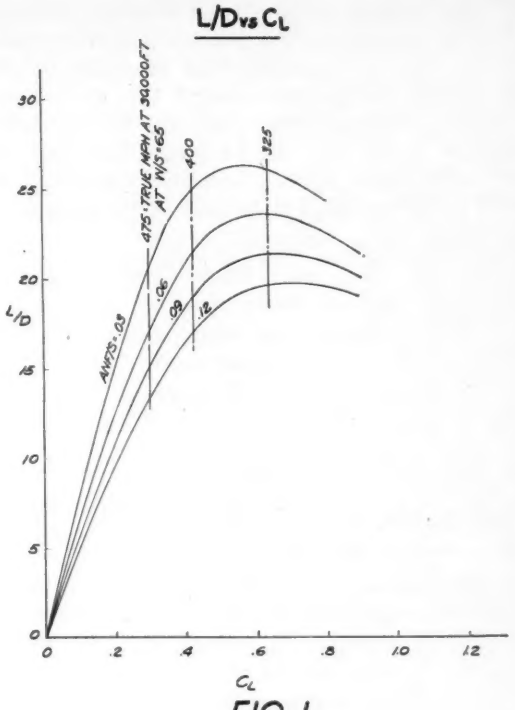

FIG. 1

L/D = airplane lift-drag ratio that varies with lift coefficient and airplane configuration. Experience has demonstrated that within the complete range of airplanes that result from this analysis, with conventional configurations, good aerodynamic design will result in equivalent drag coefficients for wing plus tail, provided the aspect ratio for all airplanes is maintained constant. From inspection of the current trend and for convenience, an aspect ratio of 10 is used throughout. The factors that vary the L/D ratio are the sizes of the fuselage and engine housing forms (nacelle for reciprocating and turbine-propeller engines). Thus, in Fig. 1, four assumed L/D curves are shown, each for a ratio of fuselage plus nacelle frontal area to wing area (A_{NF}/S), to cover adequately the variation of configuration that will be required. These curves are based on data from existing airplanes in the weight class from 50,000 to 200,000 lbs. gross weight. The effects of compressibility on drag coefficients are neglected, on the basis that the plan forms will be designed to minimize compressibility effects to the maximum Mach Number required—namely, 0.70.

V_T = true air speed at the prescribed altitude of 30,000 ft. This parameter does not ap-

pear in the Breguet Formula but is required in the analysis. Again, for simplification and from experience in the airplane sizes considered, a constant value of take-off wing loading, W_0/S = 65 lbs. per sq.ft., is assumed. Thus, the lift coefficient C_L arbitrarily corresponds to the initial flight speed by the formula:

$V_T = [65(391)/C_L(2.68)]^{1/2}$

The airplanes are assumed to fly at constant C_L values—namely:

initial V_T = 325 m.p.h.
= 400 m.p.h.
= 475 m.p.h.
C_L = 0.644
= 0.425
= 0.301

W_0 = take-off gross weight to be determined.

W_F = final gross weight to be determined.

range = the required flight range. In order to obtain typical operational results, the fuel consumed in take-off, in climb, in descent, and for reserve must be included. This is approximated by the addition of 600 miles still-air range, resulting in a 40 per cent addition for the required 1,500-mile flight and a 20 per cent addition for the 3,000-mile case.

(2) For the turbine-jet engines, the Breguet Range Formula must be changed, to be based on a specific fuel consumption in terms of pounds of fuel consumed per hour per pound of thrust developed. Thus:

$$\text{range} = 0.6825\left(\frac{2}{C_L\rho}\right)^{1/2}\left(\frac{L}{D}\right)\left(\frac{2}{f}\right)\left(\frac{W_0^{1/2}}{S} - \frac{W_F^{1/2}}{S}\right)$$

where the new factors are:

ρ = air density at 30,000 ft. = 0.000889 slug ft.$^{-4}$sec.^{2}.

f = specific fuel consumption. Using a flight altitude of 30,000 ft., the analysis is based on present fuel consumption values with available engines. The figures shown are typical values for the required speeds:

V = 325 m.p.h.
= 400 m.p.h.
= 475 m.p.h.
f = 1.32 lbs. per hr. per lb. thrust
= 1.37 lbs. per hr. per lb. thrust
= 1.40 lbs. per hr. per lb. thrust

W_0/S = initial wing loading, and as previously stated, is maintained as 65 lbs. per sq.ft.

(3) One additional relationship is required to solve this problem. The relationship of the final weight to the initial weight is stated as:

$$W_F = BW_0 + P$$

where

B = the ratio of empty to initial gross weight. In the initial step three values are assumed, and the final derivation of B will be discussed in subsequent paragraphs.

P = pay load required, three values of which are investigated—namely, 20,000, 50,000, and 100,000 lbs.

Fuselage and Nacelle Selection

The following general data have been calculated following the data and formulas in the preceding section: (1) complete data for three types of engines, reciprocating (turbosupercharged), turbine-propeller, and turbine-jet; (2) data for two ranges, 1,500 and 3,000 miles, plus 600-mile reserve; (3) data on three pay loads, 20,000, 50,000, and 100,000 lbs.; (4) data for values of nacelle plus fuselage frontal area divided by wing area, A_{NF}/S of 0.03, 0.06, 0.09, and 0.12 for subsequent interpolation; (5) data for three judiciously chosen ratios of weight empty to gross weight (B) values, for subsequent interpolation.

These are plotted for each combination of type of engine and range, as shown in the example of Fig. 2, plotting gross weight vs. A_{NF}/S, for each pay load with lines of constant speed and B values. The effect of fuselage and nacelle size (drag) on required gross weight is evident. The next step is the selection of the proper values of A_{NF}/S following the power and pay-load space requirements. The assumption is made that the resulting nacelles and fuselages will be amenable to good aerodynamic shapes, so that their unit drags will only be a function of their frontal areas. The following assumptions are required:

(1) The fuselage volume is assumed to vary only as a function of pay load, keeping a constant cargo density. Typical fuselages of current airplanes have been studied and used as a basis of obtaining the required constants. Thus, defining l as fuselage length,

fuselage volume $\sim A_F l$

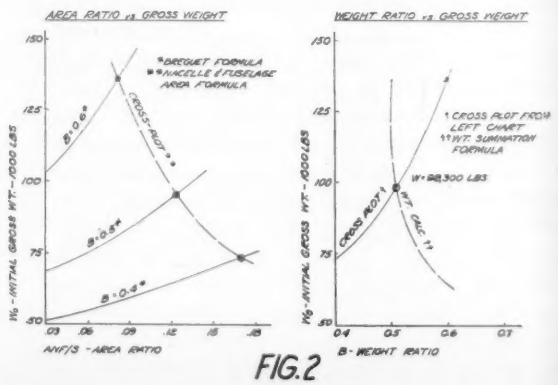
TYPICAL CROSS-PLOT DATA EXAMPLE
PAYLOAD = 20,000 LBS, INITIAL SPEED = 400 MPH, RANGE = 3000 MILES
AREA RATIO vs GROSS WEIGHT
WEIGHT RATIO vs GROSS WEIGHT
*BREGUET FORMULA
**NACELLE & FUSELAGE AREA FORMULA
CROSS-PLOT **
B=0.6*
B=0.5*
B=0.4*
* CROSS PLOT FROM LEFT CHART
** WT. SUMMATION FORMULA
W=98,300 LBS
CROSS PLOT *
WT. CHK **
Wo - INITIAL GROSS WT. - 1000 LBS
ANF/S - AREA RATIO
B - WEIGHT RATIO

FIG. 2

In order to maintain airplane stability, with the ratio of tail area to wing area already assumed constant, tail length as a function of wing chord must remain constant. With a fixed wing aspect ratio and plan form, wing chord is proportional to the square root of wing area, and for a wing loading of 65 lbs. per sq.ft.:

$$l = (S/S')^{1/2}l' = (W_0/65S')^{1/2}l'$$

For a fuselage volume proportional to pay load P,

$$A_F(W_0/65S')^{1/2}l'P' = l'A_{F'}P$$

$$A_F(W_0)^{1/2}/SP = A_{F'}(S')^{1/2}(65)^{1/2}/P'$$

A typical value of the constant on the right-hand side of the equation from design study is:

$$A_F(S)^{1/2}(65)^{1/2}/P = 133$$

$$A_F/S = 133P/(W_0)^{1/2}$$

(2) The nacelle or engine installation frontal area that affects the drag depends on the type and size of the engine considered. For each type, typical installations have been studied to arrive at values of frontal area per take-off brake horsepower (b.h.p.) for use herein. Although this must be approximate for all power requirements, inspection of the final airplane data table indicates that the optimum power plants are in the high power class.

The reciprocating and turbine-propeller engines are assumed to be housed in standard-type nacelles; the jet engines are assumed to be partially buried in the structure and to have equivalent frontal areas as shown. Thus, the following square feet (A_N) per take-off brake horsepower (b.h.p.) or take-off thrust (T) for jet engines are chosen:

reciprocating, A_N/b.h.p.	= 0.00510
turbine propeller, A_N/b.h.p.	= 0.00417
turbine jet, A_N/T	= 0.00045

It should be noted that take-off thrust augmentation is assumed for the jet engine.

(3) Adding fuselage and nacelle areas and substituting the wing loading of 65:

$$\text{reciprocating, } A_{NF}/S = \frac{133P}{(W_0)^{1/2}} + \frac{0.3315(\text{b.h.p.})}{W_0}$$

$$\text{turbine propeller, } A_{NF}/S = \frac{133P}{(W_0)^{1/2}} + \frac{0.2711(\text{b.h.p.})}{W_0}$$

$$\text{turbine jet, } A_{NF}/S = \frac{133P}{(W_0)^{1/2}} + \frac{0.0293(T)}{W_0}$$

(4) The derivation of the take-off power or thrust must be obtained for use on the preceding formulas. One of two criteria will dictate, depending upon which is larger.

(a) To obtain a consistent degree of safety, the take-off distances must be limited. Calculations show that to keep the distance to a favorable value, the product of wing loading times take-off power loading must not exceed a value of 700. Thus: b.h.p. $= 0.0929W_0$, or, for jet engines, assuming a propeller thrust power ratio at critical speed of 2.1 lbs. per hp., $T = 0.195W_0$.

(b) The second criterion, which may be more critical than the first, relates the ratio of maximum cruising power (or thrust) at 30,000 ft. to take-off power (or thrust) at sea level. This is based on the power required at the initial gross weight. Thus:

$$\text{reciprocating, b.h.p.} = \frac{\text{b.h.p. cruise}}{0.52}$$

$$\text{turbine propeller, b.h.p.} = \frac{\text{b.h.p. cruise}}{0.60}$$

$$\text{turbine jet, } T = \frac{T \text{ cruise}}{0.222}$$

As shown in the example of Fig. 2, for each speed, pay load, and per cent empty weight (B), an intersection may be obtained with the plot of gross weight vs. A_{NF}/S by the use of the preceding formulas. These intersection points define the only possible airplane for each job, except that it is now required to determine the correct value of B.

Weight Ratio Determination

The previous data on gross weight versus B may be plotted for each combination of engine type, initial flight, speed, and pay load. It is required now to determine the correct weight B. This must be accomplished from a component weight breakdown that is established in the following paragraphs. The expressions obtained are of necessity empirical, but they check with acceptable accuracy airplanes of gross weights from 60,000 to 340,000 lbs. Conventional design is still assumed to be consistent with previous derivations.

(1) l = fuselage length. Following the previous dictates for maintenance of airplane stability and based on typical values,

$$l = (W_0/65S')^{1/2}l' = (W_0/10)^{1/2}$$

(2) d = average fuselage diameter. For typical fuselages,

$$d^2l/P = 0.82$$

(3) W_3 = fuselage weight. This is the most questionable item because the fuselage weight is dependent on many factors. This formula, derived empirically, reflects the effect of surface area shear material, bending material, and constants. For gross weights less than 345,000 lbs.:

$$\frac{W_3}{W_0} = \left[1.35 + 0.55\left(\frac{W_0}{100{,}000}\right)\right]\left(\frac{ld}{W_0}\right) + \left[0.92 - 0.24\left(\frac{W_0}{100{,}000}\right)\right]\left(\frac{l^2}{100{,}000}\right)$$

For gross weights over 345,000 lbs.:

TABLE 1
RECIPROCATING ENGINE AIRPLANES

PAYLOAD — LBS	INITIAL SPEED — MPH	NUMBER ENGINES — NO.	T.O. POWER — BHP/ENG	GROSS WEIGHT — LBS	EMPTY WEIGHT — LBS
RANGE - 1500 MILES					
20,000	325	2	4650	75,600	43,500
	400	4	3850	109,500	70,600
	475	8	5050	240,000	179,000
50,000	325	4	4750	200,000	123,000
	400	8	4380	278,000	185,000
	475	18	5060	534,000	397,000
100,000	325	8	4420	395,000	242,000
	400	16	5010	727,000	528,000
	475	–	–	–	–
RANGE - 3000 MILES					
20,000	325	2	5070	99,200	55,400
	400	4	4570	147,200	91,300
	475	–	–	–	–
50,000	325	6	4120	267,000	158,000
	400	8	5300	365,000	231,000
	475	–	–	–	–
100,000	NONE POSSIBLE				

$$\frac{W_3}{W_0} = \left[1.35 + 0.55\left(\frac{W_0}{100{,}000}\right)\right]\left(\frac{ld}{W_0}\right) + 0.092\left(\frac{l^2}{100{,}000}\right)$$

(4) W_4 = weight of wing plus tail. This is similar to a commonly used wing weight formula, increased for the effects of control surfaces and tail because geometries are assumed identical.

$$W_4/W_0 = 0.076 + [(W_0)^{1/2}/4{,}850]$$

(5) W_0 = weight of landing gear, controls, hydraulics, electrical, anti-icing, and unusable fuel and oil. These factors indicate a constant per cent of gross weight.

$$W_0/W_0 = 0.081$$

(6) W_6 = crew weight. A crew of seven plus baggage is assumed for all airplanes.

$$W_6/W_0 = 1{,}400/W_0$$

(7) W_7 = weight of furnishings, air conditioning, and cabin equipment. These are assumed a function of fuselage volume only.

$$W_7/W_0 = 0.073ld^2/100{,}000$$

(8) W_8 = power-plant weight including nacelle structure, etc. These are dependent on engine type:

reciprocating, $\frac{W_8}{W_0} = \frac{2.1(\text{b.h.p.})}{W_0}$

turbine propeller, $\frac{W_8}{W_0} = \frac{1.4(\text{b.h.p.})}{W_0}$

turbine jet, $\frac{W_8}{W_0} = \frac{0.44(T)}{W_0}$

TABLE 2
TURBINE-PROPELLER ENGINE AIRPLANES

PAYLOAD — LBS.	INITIAL SPEED — MPH	NUMBER ENGINES — NO.	T.O. POWER — BHP/ENG	GROSS WEIGHT — LBS.	EMPTY WEIGHT — LBS.
RANGE - 1500 MILES					
20,000	325	2	2710	58,100	26,300
	400	2	5350	74,300	39,200
	475	4	5250	115,800	70,500
50,000	325	4	4000	172,000	94,000
	400	4	5750	194,400	110,500
	475	–	–	–	–
100,000	325	6	5330	344,000	191,500
	400	8	5100	379,000	218,000
	475	–	–	–	–
RANGE - 3000 MILES					
20,000	325	2	3500	75,800	34,700
	400	4	3000	98,300	50,100
	475	6	4280	164,000	95,500
50,000	325	4	5200	223,000	119,000
	400	6	4400	251,500	138,000
	475	10	5700	390,000	231,000
100,000	325	8	5400	466,000	260,000
	400	10	5230	550,000	319,000
	475	–	–	–	–

(9) B = ratio of equipped empty to gross weight.

$$B = \frac{W_3}{W_0} + \frac{W_4}{W_0} + \frac{W_5}{W_0} + \frac{W_6}{W_0} + \frac{W_7}{W_0} + \frac{W_8}{W_0}$$

The weight ratio values B have been calculated and cross-plotted as shown in a typical example in Fig. 2. The intersection of B dictated by the performance derivation and B derived from the weight build-up, indicates the final airplane gross weight required for each pay load, speed, and range combination.

Derivations

Tables 1, 2, and 3 present the airplane derived from this analysis. In each case, a number of engines is chosen assuming typical power ratings. By inspection of these tables the following facts are apparent:

(1) Because of the structural weight and fuel requirements based on present-day limitations, the most extreme requirement of 100,000 lbs. pay load, 475 m.p.h. initial speed, and 3,000-mile range cannot be fulfilled.

(2) Airplanes equipped with reciprocating engines are larger and heavier than those equipped with turbine-propeller engines for all ranges and conditions. This is a result of the fact that the power ratings relative to engine weight and size and the ratio of maximum cruising power to take-off power are more advantageous for the turbine-propeller engines. The advantage in specific fuel consumption of the present reciprocating engine over the turbine-propeller engine is not great enough to overcome the other disadvantages for the ranges investigated.

(3) The jet engine today is not capable of powering an airplane designed to accomplish the longer range jobs listed.

TABLE 3

TURBINE-JET ENGINE AIRPLANES

PAYLOAD — LBS	INITIAL SPEED — MPH	NUMBER ENGINES — NO.	T.O. THRUST — LBS/ENG	GROSS WEIGHT — LBS	EMPTY WEIGHT — LBS
RANGE- 1500 MILES					
20,000	325	4	5500	98,000	41,850
	400	4	6000	95,000	41,400
	475	5	6200	108,000	49,100
50,000	325	8	6330	260,000	125,600
	400	7	7000	252,000	125,200
	475	8	7000	278,000	141,100
100,000	325	—	—	—	—
	400	16	7000	575,000	314,000
	475	20	7000	715,000	421,000
RANGE- 3000 MILES					
NONE POSSIBLE					

TABLE 4

AIRPLANE SPECIFICATION DATA

PAYLOAD LBS	20,000			50,000			100,000		
INITIAL SPEED MPH	325	400	475	325	400	475	325	400	475
RANGE- 1500 MILES									
ENGINE TYPE	T.P.	T.P.	JET	T.P.	T.P.	JET	T.P.	T.P.	JET
WEIGHT: TAKE-OFF 1000 LBS	58.1	74.3	108.0	172.0	194.4	278.0	344.0	379.0	715.0
WEIGHT: EMPTY 1000 LBS	26.3	39.2	69.1	94.0	110.5	141.1	191.5	218.0	421.0
WING AREA 100 FT²	8.9	11.4	16.6	26.5	29.9	42.8	53.0	58.0	110.0
FUEL: FLIGHT 1000 LBS	8.4	10.8	27.8	20.0	24.2	62.0	37.5	43.5	139.0
FUEL: TOTAL 1000 LBS	11.8	15.1	38.9	28.0	33.9	86.9	52.5	61.0	194.0
BLOCK SPEED MPH	293	357	410	300	369	426	300	369	430
RANGE- 3000 MILES									
ENGINE TYPE	T.P.	T.P.	T.P.	T.P.	T.P.	T.P.	T.P.	T.P.	—
WEIGHT: TAKE-OFF 1000 LBS	75.8	98.5	164.0	223.0	251.5	390.0	466.0	550.0	—
WEIGHT: EMPTY 1000 LBS	34.7	50.1	95.5	119.0	138.0	231.0	260.0	319.0	—
WING AREA 100 FT²	11.7	15.1	25.2	34.3	38.7	60.0	72.0	84.5	—
FUEL: FLIGHT 1000 LBS	17.6	23.5	40.4	45.0	53.0	91.0	88.0	109.0	—
FUEL: TOTAL 1000 LBS	21.1	28.2	48.5	54.0	63.5	109.0	106.0	131.0	—
BLOCK SPEED MPH	300	366	436	303	372	438	303	372	—

TABLE 5

AIRPLANE CHARACTERISTICS DATA

PAYLOAD LBS	20,000			50,000			100,000		
INITIAL SPEED MPH	325	400	475	325	400	475	325	400	475
RANGE- 1500 MILES									
ENGINES NUMBER	2	3	5	4	4	8	6	8	20
T.O. POWER BHP/ENG*	2710	5330	(6200)	4000	5750	(7000)	5330	5100	(7000)
FUSELAGE DIAMETER FT	14.7	13.8	12.5	17.7	17.2	15.7	21.0	20.5	17.5
POWER LOADING LBS/H.P.*	10.7	7.0	(5.9)	10.7	8.4	(5.0)	10.7	9.3	(5.1)
PAYLOAD/T.O. WT. LB/LB	.344	.269	.184	.291	.256	.180	.290	.263	.140
EMPTY WT/T.O. WT. LB/LB	.452	.527	.456	.547	.570	.508	.537	.577	.590
TOTAL FUEL/T.O. WT. LB/LB	.204	.204	.360	.162	.174	.312	.153	.160	.270
RANGE- 3000 MILES									
ENGINES NUMBER	2	4	6	4	6	10	8	10	—
T.O. POWER BHP/ENG*	3300	3000	4280	5200	4400	5700	5400	5230	—
FUSELAGE DIAMETER FT.	13.8	12.9	11.3	16.6	16.1	14.4	19.5	18.7	—
POWER LOADING LBS/H.P.*	10.7	8.2	6.4	10.7	9.6	6.8	10.7	10.5	—
PAYLOAD/T.O. WT. LB/LB	.263	.203	.122	.225	.199	.128	.214	.182	—
EMPTY WT/T.O. WT. LB/LB	.458	.510	.582	.533	.549	.592	.558	.580	—
TOTAL FUEL/T.O. WT. LB/LB	.279	.287	.296	.242	.252	.280	.228	.238	—

*(THRUST/ENGINE) FOR JET UNITS, SEA LEVEL, STATIC
**(LBS/LB THRUST) FOR JET UNITS

(4) For the shorter range, the jet engine airplane is more efficient at the intermediate speed than at the lower speed.

(5) For short range intermediate and high speed, the jet engine airplane is superior in size to the reciprocating engine airplane.

(6) For short range at the highest speed, the jet engine airplane is superior to either of the other engines.

(7) Only a jet-engine airplane can accomplish the job of carrying 100,000 lbs., 1,500 miles, at 475 m.p.h.

Explanation of these results can be traced back to engine ratings, engine sizes and weights, and fuel consumption. These are results for particular conditions chosen, and other chosen conditions would vary them. For example, if extreme long range were required, with relatively small pay load, the reciprocating engine would show to better advantage. Also, if altitudes were reduced by dictation, the reciprocating engine would be benefited and the turbine engine penalized. It should be noted however, that to obtain the maximum capabilities of a turbine-engine airplane, the flight altitude should not be restricted. A turbine-engine airplane obtains optimum range performance if its altitude can be continually increased as its weight is reduced during a range flight, resulting in a variable altitude type of operation that is not so readily analyzed by simple formulas.

It is recognized that all three types of engines will be considerably improved in the future. However, it is this author's opinion that if the relative advantages are changed, the result will be further in favor of the turbine engines.

Airplane Specification Data

Having derived the relative size of airplanes to perform specified jobs, it is interesting to compare them to determine the effects of design pay load, speed, and range. To do this, the smallest airplane is selected by inspection of Tables 1, 2, and 3, and entered in Table 4. Study of that table reveals the following:

(1) The turbine-propeller type engine is optimum for all airplanes derived except those designed to fly short range at 475 m.p.h.

(2) For the lower speed, 20,000-lb. pay-load class, the gross weights shown are slightly less than comparable current airplanes, mainly because the table reflects the twin-engined types, while current airplanes capable of accomplishing this job have four engines each with lower power ratings.

(3) Comparison in gross weight for the lower speed, 50,000-lb. pay-load class indicates good agreement with current designs.

(4) Airplanes designed for a 100,000-lb. pay load would weigh from 344,000 to 715,000 lbs., with wing areas from 5,300 to 11,000 sq.ft. A jet-engine transport could be built to carry 100,000 lbs., 1,500 miles, averaging 430 m.p.h., a take-off gross weight of 715,000 lbs.,

equipped with twelve 6,920-lb. take-off thrust engines, burning 194,000 lbs. of fuel.

(5) Flight fuel is the fuel required for the basic distance without the 600-mile reserve.

(6) The speeds listed on the top of the table are initial speeds. For illustration, these are converted to block-to-block speeds by calculating the speed at the average weight at the prescribed lift coefficient and correcting for take-off, climb, and descent by a factor of 0.95 for short range and 0.98 for long range. Thus, the block speeds are in the order of 25 to 65 m.p.h. slower than the initial speeds.

Airplane Characteristics Data

Table 5 is presented in explanation of the results tabulated in the preceding Table 4. This table illustrates that:

(1) The largest engines are not always required.

(2) A large number of jet engines is required as would be expected with the power ratings assumed.

(3) Carrying large pay loads at the highest speed for the longer range requires too many engines at the assumed ratings, and higher power units are therefore desirable.

(4) The fuselage diameter is listed, as derived from preceding formulas. Although their equivalent diameter varies with speed, the resulting values are reasonable for cargo aircraft.

(5) The power loadings are shown to illustrate which airplane power plants are dictated by the take-off safety criterion and which by the altitude cruising power requirement. A power loading 10.7 lbs. per hp. (5.1 lbs. per lb. thrust) indicates that the take-off criterion dictated. For the slowest speed requirement, power is dictated by the safety criterion. Except for the 100,000-lb. pay load, high-speed condition, all other power requirements result from the cruising powers necessary at altitude.

(6) Dividing the gross weight into its three components, jet airplanes have relatively lower air-frame weight and higher fuel weight. The per cent pay-load weight to gross weight is relatively low for high-speed jet airplanes.

(7) The effect of increasing the pay load required is to increase the ratio of air-frame weight to gross weight. The ratio of fuel weight to gross weight is affected very little.

(8) The effect of increase of required speed is similar to the effect of increased pay-load requirement in that the air-frame weight changes the most.

(9) The effect of increased range requirements runs up the fuel weight ratio but has little effect on the air-frame weight ratio.

(10) Increasing the required pay load, range, or speed decreased the ratio of pay load to gross weight.

Airplane Comparison

Table 6 shows an attempt to compare economic advantage of size, speed, and range. There are many

TABLE 6

AIRPLANE COMPARISON DATA

PAYLOAD LBS	20000			50,000			100,000		
INITIAL SPEED MPH	325	400	475	325	400	475	325	400	475
RANGE - 1500 MILES									
PAYLOAD TONS/HR/PLANE	1.95	2.38	2.73	5.00	6.13	7.10	10.00	12.30	14.30
TO CARRY 10 TONS/HR A DISTANCE OF 3000 MILES:									
NUMBER OF PLANES	10.2	8.4	7.3	4.0	3.3	2.8	2.0	1.6	1.4
TONS OF EMPTY WT.	134	165	180	188	180	199	191	177	295
TONS OF FUEL/HR	8.4	10.8	27.7	8.0	9.6	24.8	7.5	8.6	28.0
$DEPRECIATION COST/HR.	154	226	847	258	247	273	261	243	405
$FUEL COST/HOUR	303	388	1000	288	347	890	270	311	1010
$DEPR.+FUEL COST/HR	457	614	1847	546	594	1163	531	554	1415
RANGE - 3000 MILES									
PAYLOAD TONS/HR/PLANE	1.00	1.22	1.46	2.52	3.10	3.65	5.05	6.20	—
TO CARRY 10 TONS/HR A DISTANCE OF 3000 MILES:									
NUMBER OF PLANES	10.2	8.2	6.8	3.9	3.2	2.7	2.0	1.6	—
TONS OF EMPTY WT.	174	206	327	235	222	315	238	258	—
TONS OF FUEL/HR	8.8	11.7	20.2	9.0	10.6	18.1	8.8	10.9	—
$DEPRECIATION COST/HR.	238	283	450	322	305	432	353	353	—
$FUEL COST/HOUR	317	422	730	324	380	650	318	392	—
$DEPR.+FUEL COST/HR.	555	705	1180	646	685	1082	671	745	—

methods of evaluating airplanes, both dialectical and mathematical. The dialectical approach can argue the advantages of nonstop flights and reduced number of aircraft by increased size. The mathematical approach can deduce the least costly type of airplane in terms of dollars, pounds of fuel, or man-hour requirements.

History indicates that speed is desirable because of man's insistence for saving time, even though it can be mathematically shown that it is more expensive. The geographical location of airports prescribes range requirements, and such operational factors often disprove the most scientifically deduced airplane optimum. However, Table 6 shows a simplified mathematical comparison of the airplanes derived from the foregoing analysis to indicate the relative costs of airplane design requirements of speed, pay load, and range. This table illustrates the following facts:

(1) The first line shows the obvious, that an airplane flying a short range can deliver more pay load per hour than one flying a long distance. Therefore, in order to obtain a comparison, an objective of a 3,000-mile operation is established with a figure of 10 tons of pay load to be delivered per hour as the averaged hourly cargo delivery requirement.

(2) The number of planes required is the 10-ton requirement divided by the delivery capacity of one airplane. The faster the airplane and the greater the unit pay load, the smaller the number of planes required. Furthermore, nonstop operation in nearly all cases requires fewer units because the block-to-block speed is greater.

(3) A figure merit in the operation of a fleet of aircraft is summation of the empty weight of the vehicles required for a specified operation. This addition shows that the tons of air frames required is least for the smallest, slowest, shorter range airplane type. However, if larger pay loads are dictated by other requirements, the intermediate speed gives the optimum airplane in respect to total fleet empty weight. Increased nonstop range obviously dictates greater total empty weight.

(4) The total fuel requirement per unit time for delivery of pay load at a prescribed rate is a measure of

fuel costs and of fuel delivery problems. Use of an airplane designed for short range results in a slightly smaller fuel requirement than a long-range airplane. For this optimum short-range airplane, the greater the design pay load, the smaller the fuel requirements. The lower speed requires the least fuel, with the net result that the 100,000-lb. pay load, 1,500-mile range, 325-m.p.h. design speed airplane is the optimum in this respect. The jet airplane is obviously disproportionally high in this fuel requirement comparison, although, as demonstrated in the 3,000-mile range table where all aircraft have turbine-propeller engines, increasing the speed to 475 m.p.h. caused a marked increase in fuel consumption.

(5) An attempt is made in the last three items in Table 6 to weigh the importance of the air-frame weight and fuel weight factors, so that a net comparison of these two factors could be obtained. Since, in the derivation of operating costs by any set standard formulas, most expenses are a function of either empty weight or fuel weight, summing the depreciation cost plus the fuel cost gives a fair comparison of total operating cost. Thus, the following assumptions in the following paragraphs are made.

(6) The airplanes are assumed to have a utilization of 10 hours per day and a complete depreciation in 6 years. The air-frame cost including engines, propellers, etc., is assumed a constant of $15 per lb. Both of these factors actually are variable, dependent on many operational conditions. The latter, in particular, is known to vary with airplane size and type and, even more markedly, to vary with number of airplanes constructed by the manufacturer. Thus, a more rigorous analysis would attempt to account more accurately for these variables but, even so, would require predictions of future trends that would in themselves be questionable. Therefore, this author has chosen this simplified formula, and any desired variation can be made by the reader if he so desires. The formula becomes:

$$\text{depreciation cost} = 1.37 \times \text{tons of empty weight} = \text{dollars per hour}$$

(7) Since all the aircraft compared in Table 6 are powered with turbine engines, kerosene is assumed to be the fuel. A fuel cost of 12 cents per gal. is assumed from available data. The formula becomes:

$$\text{fuel cost} = 36 \times \text{tons of fuel per hour} = \text{dollars per hour}$$

(8) Inspection of the table shows that, under the 10 tons per hour for 3,000-mile operation assumption, the slowest aircraft with the larger pay loads have approximately equal fuel and depreciation costs. For all other airplanes, the fuel costs are considerably greater than the depreciation cost, with the jet aircraft having a maximum ratio as high as four to one. Speed accentuates the fuel costs.

(9) The summation of fuel and depreciation costs indicates that the slowest airplane is the cheapest for any size. The low pay-load airplane designed for short range is the cheapest to operate. However, if the larger pay-load type is dictated, the cost of operation of a 400-m.p.h. airplane is only slightly greater than a 325-m.p.h. type. The 475-m.p.h. type is presently relatively expensive. Furthermore, if the higher speeds are dictated, the airplanes with the greater design pay load are more economical. Ignoring geographical limitations, use of airplanes designed for long-range operation is somewhat more expensive than use of those designed for the shorter range. If a 3,000-mile nonstop range at cruising speed near 400 m.p.h. is desired, the 50,000-lb. pay-load type is the optimum.

Conclusion

The analysis method presented allowed a direct calculation of the sizes and characteristics of a table of airplanes, indicating the effect of speed, pay load, and range. Although general assumptions must be made, the results are logical, and the relative effects of speed, pay load, and range are accurate. It is interesting to note the following facts:

(1) The most efficient airplane designed for a 20,000-lb. pay load at the slowest speed closely parallels the currently desired air-line cargo type. A twin-engined, 58,000-lb. transport with engines rated at 2,700 b.hp. each is the type and size currently specified by many air-line personnel.

(2) For the longer range, intermediate speed, 20,000-lb. pay-load class, an airplane of 98,000 lbs. gross weight powered by four 3,000-b.hp. engines evolves. This is the Lockheed Constellation-size aircraft, with slightly higher performance because of the assumed use of turbine-propeller engines.

(3) In the 50,000-lb. pay-load class the Lockheed Constitution airplane is closely approximated. Four engines at 5,200 b.hp. each results in a gross weight of 223,000 lbs. for a 3,000-mile range.

(4) The 20,000-lb. pay-load, short-range, 475-m.p.h. jet airplane is entirely practical. A gross weight of 108,000 lbs. is required with a total take-off thrust required of 31,000 lbs. The wing area is 1,660 sq.ft. A further increase in cruising speed could be obtained with little sacrifice in additional gross weight.

I.A.S. Briefs

Summaries of current papers received for publication or presentation at I. A. S. meetings

Many of these papers, after being processed by the Editorial Committee in the usual manner, will appear in full in later issues of the JOURNAL *or* REVIEW.

Preprints of these papers are not available at this time.

A Simplified Punch-Card Approach to the Solution of the Flutter Determinant*

By

William D. Bell

Telecomputing Corporation

Significant improvements in time, cost, and operating technique for solving flutter determinants through the use of punched-card machines are explained. These advances are due to a new approach to the handling of complex numbers, to better operating techniques, and to superior equipment now available.

* To appear in a forthcoming issue of the JOURNAL OF THE AERONAUTICAL SCIENCES.

Dependence of the Stress-Strain Curves of Cold-Worked Metals Upon the Testing Direction*

By

L. J. Klinger and G. Sachs

Case Institute of Technology

The yield strength and stress-strain curve of a cold-worked aluminum-alloy plate depend considerably upon the angle between the directions of the largest principal strains in cold-working and testing, respectively. This directionality develops as a result of a small amount of cold-work and then remains approximately constant. The effect is closely related to the Bauschinger effect.

* To appear in a forthcoming issue of the JOURNAL OF THE AERONAUTICAL SCIENCES.

The Flow at the Rear of a Two-Dimensional Supersonic Airfoil*

By

A. Kahane and Lester Lees

Princeton University

The flow at the rear of a two-dimensional airfoil moving at supersonic speed is of interest from a stability standpoint since the tail surfaces are likely to be influenced by this flow field.

The flow angle immediately behind the trailing edge of a flat-plate airfoil and an airfoil with thickness has been calculated herein on the basis of oblique shock and Prandtl-Meyer wave theory. The deflection angle of the flat-plate airfoil at a given Mach Number is shown to the first order to vary as the fourth power of the angle of attack. The magnitude of the flow deflection between Mach Numbers of 1.2 to 5.0 is very small, being always less than 0.06° for an angle of attack of 0.1 rad. (5.73°). The mechanism of the return of the flow downstream of the airfoil to the free-stream direction is also discussed.

The problem of the flow deflection immediately rearward of the two-dimensional supersonic airfoil has been previously treated in R. & M. No. 1930; the results of that paper, however, appear to be in error.

* To appear in a forthcoming issue of the JOURNAL OF THE AERONAUTICAL SCIENCES.

Note on the Simple Ram-Air Intake Preceded by Normal Shock in Supersonic Flight*

By

John D. Stanitz

National Advisory Committee for Aeronautics

This note considers the performance of a simple ram-air intake at supersonic flight speeds. The intake is preceded by a normal shock after which the flow is diffused at subsonic velocities. Exact expressions are developed for the ram pressure ratio and the ram efficiency as functions of the flight Mach Number and the diffuser efficiency. In addition, a simple approximate equation is developed for the ram pressure ratio at flight Mach Numbers greater than 2.0. The conclusions of this analysis are: (1) for flight Mach Numbers greater than 2.0 the ram pressure ratio varies approximately with the square of the Mach Number, (2) for a diffuser efficiency of 1.0 the minimum ram efficiency is 0.76, (3) for very high flight Mach Numbers the ram efficiency becomes asymptotic to 1.0, and (4) for diffuser efficiencies less than 1.0 the ram efficiency is improved by normal shock compression at low flight Mach Numbers.

* To appear in a forthcoming issue of the JOURNAL OF THE AERONAUTICAL SCIENCES.

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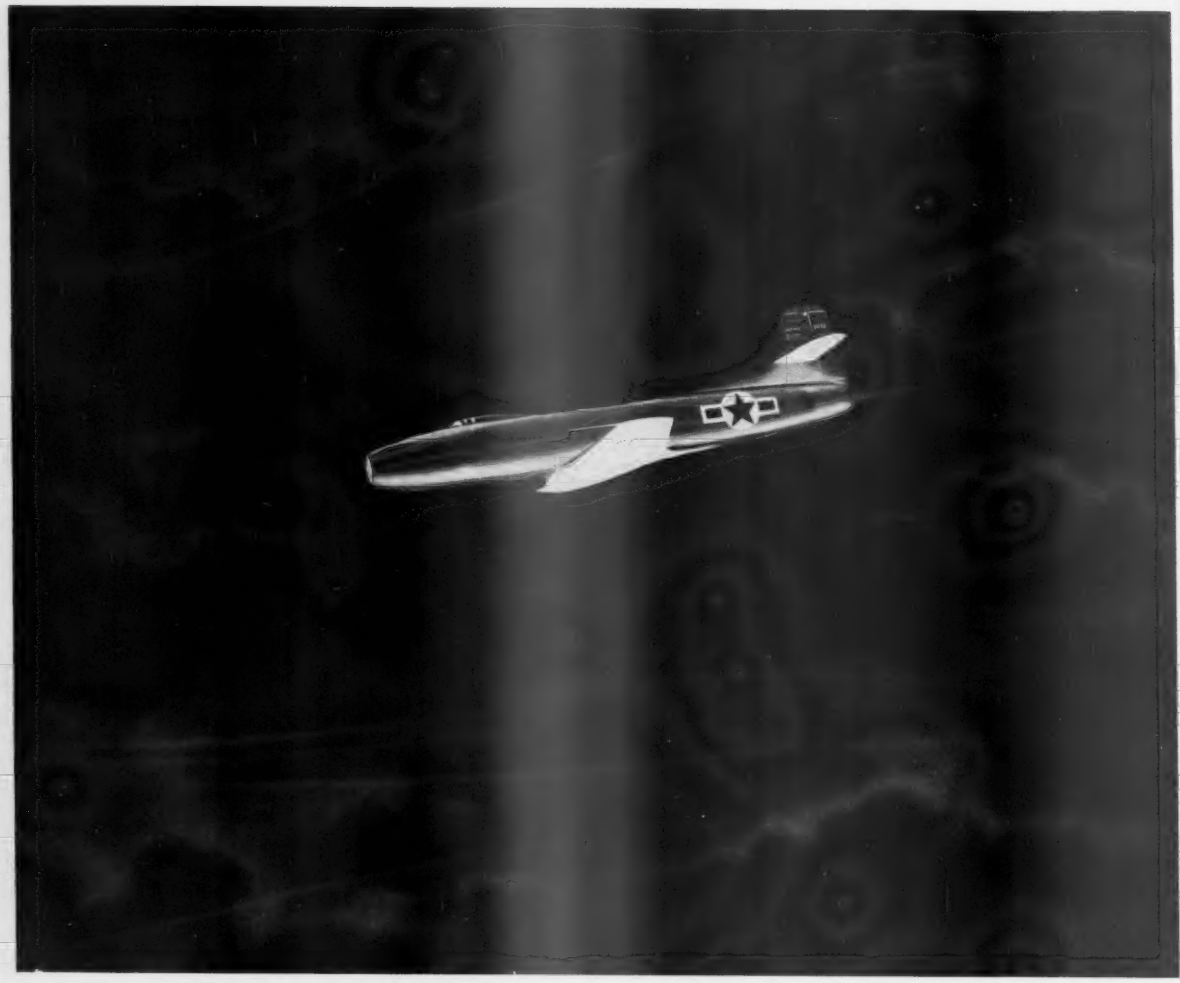

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Aeronautical Reviews

Aerodynamics

The Linearized Subsonic and Supersonic Flow About Inclined Slender Bodies of Revolution. E. V. Laitone. *Journal of the Aeronautical Sciences*, Vol. 14, No. 11, November, 1947, pp. 631–642, figs. 15 references .

Rigorous first-order linearized solutions are obtained. The surface pressures are found by means of a Taylor's Series expansion in terms of the cross-sectional area. The resulting simple expressions are in satisfactory agreement with existing experimental data. Previous solutions of the linearized supersonic flow equations have retained terms that at high Mach Numbers are incompatible with the basic potential equation of compressible flow. Extremely simple relations are developed for the lift and moment of bodies of revolution in inclined and curvilinear subsonic and supersonic flow. These relations are in good agreement with experimental measurements. The commonly used linearized solution for the supersonic flow about an inclined body of revolution is incorrect, since nearly all of the terms retained are of a higher order than the terms omitted in neglecting the effect of the velocity component due to the axial flow and in not considering the complete boundary conditions. The rigorous analysis indicates that the linearized theory cannot predict correctly the variation of the surface pressure coefficient at high Mach Numbers.

The Dynamics of a Swept Wing. H. R. Lawrence. *Journal of the Aeronautical Sciences*, Vol. 14, No. 11, November, 1947, pp. 645–650, diagrs. 4 references.

It is assumed that a swept wing may be represented dynamically by a plane curved rod of variable cross section with finite stiffness in torsion and in bending normal to its plane. The equations of motion for this configuration are exhibited with the restriction that the curvature of the elastic axis be finite. By allowing the curvature to become infinite at a point, certain auxiliary conditions are obtained at the bend. The validity of this limiting process is examined from the physical point of view. A wing with an elastic axis consisting of a plane broken line of $(n + 1)$ is denoted as an "n bend wing." A method is developed for calculating the natural frequencies and modes of a single bend wing. Formulas for the natural frequencies and modes of a free-free symmetric single bend uniform rod are obtained. The generalized type of orthogonality condition between the modes of a single bend wing is proved. Based on these results, formulas are developed for the dynamic response of a single bend wing to a general system of forces. A method of generalizing the above results for a single bend wing to the n bend wing is indicated. The use of an n bend wing as an approximate representation of a wing of continuous curvature is discussed.

Fluid Dynamic Aspects of Axial-Flow Compressors and Turbines. John R. Weske. *Journal of the Aeronautical Sciences*, Vol. 14, No. 11, November, 1947, pp. 651–656, diagrs. 2 references.

Pertinent facts of the two-dimensional theory of flow through blade grids are used to establish relationships for the three-dimensional flow through axial blade rows. Certain aspects of flow in boundary layers and wakes encountered in blade rows are investigated qualitatively, particularly with regard to their effect upon operating characteristics. A criterion of stability of flow is proposed and defined mathematically.

Ducted Fans: A Nomogram Method of Analysis. J. F. M. Scholes. *Australia, Council for Aeronautics, Report No. ACA-32*, February, 1947. 22 pp., figs. 6 references.

The performance of any given ducted fan of R.A.F. 6 (Section E) blade section may be determined from nomogram charts presented. The method of constructing the charts is indicated. Accuracy is good if compressibility and blade interference effects are negligible. Three types of fans are analyzed: a single fan without straightener, a single fan with N.P.L. straighteners, and a pair of counterrotating fans.

Resistance Derivatives of Flutter Theory. II—Results for Supersonic Speeds. A. R. Collar. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2139*, January, 1944. 11 pp., figs. 5 references. British Information Services, New York. $0.75.

A set of two-dimensional flutter derivatives is obtained for an airfoil and flap moving at supersonic speeds. The basis for the analysis is the assumption that Ackeret's theory of steady flow may be applied without modification to the case of nonsteady flow. The results may therefore be valid only for certain restricted conditions, but they should be qualitatively accurate. A comparison with results for subsonic speeds shows that the signs and orders of magnitude of the derivative coefficients are the same in the subsonic and supersonic regions. Results are compared with later work by Temple and John.

A Review of Turbulence Theories. Betty L. Cumming. *Australia, Council for Aeronautics, Report No. ACA-27*, August, 1946. 22 pp. 54 references.

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The mixing-length theories of turbulence, the continuous statistical theory, and the theory introduced by Synge and Lin, which assumes that turbulence is caused by the chaotic motion of many "Hill" spherical vortices, are outlined in detail and compared. Their development is traced and the practical results that can be obtained by each method are shown. The current knowledge on the behavior of flow in a wind tunnel is analyzed to point out the inadequacies of the present theories.

Note on the Application of the Linearised Theory for Compressible Flow to Transonic Speeds. A. Robinson and A. D. Young. *College of Aeronautics, Cranfield, England, Report No. 2,* January, 1947. 9 pp., figs. 7 references.

For finite aspect ratio the linearized theory of compressible flow remains theoretically consistent in the region of transonic speeds, although its predictions may deviate appreciably from experimental results in that region. The variation of the theoretical lift curve slope of an airfoil of finite span is considered as the Mach Number increases from below unity to above unity. It is shown that the lift curve slope remains finite and continuous.

Note on the Velocity and Temperature Distributions Attained with Suction on a Flat Plate of Infinite Extent in Compressible Flow. A. D. Young. *College of Aeronautics, Cranfield, England, Report No. 8,* August, 1947. 9 pp., fig. 2 references.

The problem considered by Griffith and Meredith for incompressible flow is considered for compressible flow with the assumption that there is no heat transfer by conduction at the plate. Essentially, the method consists of establishing a correspondence between the velocity and temperature profiles for incompressible flow and those for compressible flow, the lateral ordinates being scaled by factors that are functions of the ordinates and of the Mach Number. Calculations are made for a range of Mach Numbers up to 5.0. The solution is recorded for its intrinsic interest rather than for its immediate practical importance.

Influence of Compressibility on Interference Drag. Sighard Hoerner. (*Oberbayerische Forschungsanstalt, Oberammergau, ZWB/UM/7842,* December, 1944.) *U.S., Army Air Forces, Translation No. F-TS-1518-RE,* July, 1947. 18 pp., diagrs. 3 references.

Tests on a cross-type tail to determine the interference drag were made in the high-speed wind tunnel of the Heinkel Works. When the results were plotted against the cube of the Prandtl factor, it was found that the interference drag, which is a pressure drag, increases in a manner similar to the friction drag but possibly with a power higher than the third. The slow increase in drag with the Mach Number after the critical Mach Number had been exceeded is attributed to the gradual spread of the stall from the intersections of the tail over the surfaces.

Cones in Supersonic Flow. W. Hantzsche and H. Wendt. (*Jahrbuch der Deutschen Luftfahrtforschung,* 1942, pp. I80–I90.) *U.S., N.A.C.A., Technical Memorandum No. 1157,* August, 1947. 27 pp., illus. 5 references.

Adiabatic compression takes place between shock waves and the surface of the cone in axially symmetric supersonic flow. Interpolation curves between shock polars and the surface are therefore necessary for the complete understanding of this type of flow. Suitable curves are plotted by graphical-numerical integration of the differential equation for all cone angles and air speeds.

Investigation of Free Turbulent Mixing. Hans Wolfgang Liepmann and John Laufer. *U.S., N.A.C.A., Technical Note No. 1257,* August, 1947. 59 pp., illus. 21 references.

The integral equations for flow of the boundary-layer type are applied to the jet and the mixing zone in order to obtain the characteristic laws of spread of jet and wakes in the laminar case. By the application of dimensional reasoning, these laws can also be obtained for the turbulent case. The intensity and scale of the turbulent fluctuations, the mean velocity, and the turbulent shear were measured in a two-dimensional mixing-zone. The measurements show that theories based on the assumptions of either constant mixing length or constant exchange coefficient are in error. A discussion of the energy and momentum integral relations for the mean and fluctuating motion shows that the overall characteristics of a turbulent mixing process can be obtained by dimensional reasoning without any assumptions for the physical mechanism of turbulent motion.

Investigation of Compressible Flow on and Near a Curved Profile. W. Froessel. (*Göttingen, Kaiser-Wilhelm-Institut für Strömungsforschung, ZWB/KWI/2,* March, 1945.) *U.S., Army Air Forces, Translation No. F-TS-1517-RE,* August, 1947. 38 pp., illus.

Schlieren photographs were used to determine the flow phenomenon produced by a circular profile with a radius of 100 mm. and a chamber height of 10 mm. in two-dimensional compressible flow. A tangential extension downstream of the profile was provided which could be set at various pitches to the axis of flow. The effect of various settings of the extension on the constant-velocity flow can be compared from the photographs.

Boundary-Layer Momentum Equations for Three-Dimensional Flow. Neal Tetervin. *U.S., N.A.C.A., Technical Note No. 1479,* October, 1947. 27 pp., figs. 8 references.

Equations for the three-dimensional flow of a fluid with variable density and viscosity are presented in a form similar to the momentum equations for two-dimensional flow. The momentum equations can be reduced to the forms of the three-dimensional momentum equations that have been given recently by Prandtl for a fluid with constant density and viscosity. When the flow becomes two-dimensional, the momentum equation first given by von Kármán results. For flow in a convergent or divergent channel, the equations reduce to the equations previously given by A. Kehl for a fluid with constant density and viscosity.

Gravitational Diffusion from a Boundary Source in Two-Dimensional Flow. Hunter Rouse. *Journal of Applied Mechanics,* Vol. 14, No. 3, September, 1947, pp. A-225–A-228, figs.

A general analysis of turbulent diffusion. An error distribution of the specific-weight difference over any normal section is taken into account, and the standard deviation of the error curve is assumed to be directly proportional to the mixing length. The results of experiments are shown to be in good agreement with theoretical calculations.

Calculations and Experimental Investigations of the Feed-Power Requirements of Airplanes with Boundary-Layer Control. W. Krüger. (*ZWB/FB/1618,* April 27, 1942.) *U.S., N.A.C.A., Technical Memorandum No. 1167,* September, 1947. 56 pp., diagrs. 4 references.

A survey of the design requirements of boundary-layer control installations. The power required to maintain control at a given lift coefficient is calculated for suction over the entire span, blowing over the entire span, and for suction in the landing flap and blowing in the aileron region of the wing. The calculations are made for a specific airplane design. Formulas and work sheets are given from which sufficient information can be obtained to indicate in the preliminary design the influence of individual de-

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sign features on the pressure and feed-power requirements. Tests were made which confirmed the calculations and demonstrated that the installation that uses either suction in the landing-flap region or blowing in the aileron region is superior to the other two types investigated.

The Stability Derivatives of Low-Aspect-Ratio Triangular Wings at Subsonic and Supersonic Speeds. Herbert S. Ribner. *U.S., N.A.C.A., Technical Note No. 1423*, September, 1947. 34 pp., figs. 7 references.

The flow potential is assumed to be in planes at right angles to the long axis of the airfoil and similar to the corresponding two-dimensional potentials. Pressure distributions caused by downward acceleration, pitching, rolling, sideslipping, and yawing are calculated for wings with and without dihedral. The stability derivatives calculated from these distributions are expected to apply at subsonic and supersonic speeds but not in the transonic region. The maximum speed at which they will apply in the transonic region is that speed at which the triangle is no longer narrow compared with the Mach cone formed at its vertex.

Supersonic Wave Drag of Sweptback Tapered Wings at Zero Lift. Kenneth Margolis. *U.S., N.A.C.A., Technical Note No. 1448*, October, 1947. 49 pp., diagrs. 4 references.

Equations are derived for the supersonic wave drag of sweptback tapered wings with thin symmetrical double-wedge sections at zero lift. Variations in drag with taper ratio, aspect ratio, sweepback, and Mach Number are determined. Families of tapered wings having equal root bending stress have been calculated.

The Effects of Yawing Thin Pointed Wings at Supersonic Speeds. John C. Evvard. *U.S., N.A.C.A., Technical Note No. 1429*, September, 1947. 26 pp., figs. 6 references.

An approximate solution for the surface velocity potential of thin pointed wings at supersonic speeds when the leading edges are included within the Mach cone from the vertex. The aerodynamic coefficients of the delta wing as functions of the angle of yaw are calculated. Curves plotted for Mach Number $\sqrt{2}$ illustrate these relations.

Aerodynamic Forces on Wings in Non-Uniform Motion. W. Prichard Jones. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2117*, August, 1945. 36 pp., figs. 33 references. British Information Services, New York. $1.95.

Determination of the aerodynamic forces acting on wings of finite span in nonuniform motion in an incompressible, non-viscous fluid. The underlying theory is outlined and some known results for the case of an airfoil of infinite span are given. It is shown by the use of operational methods that the growth of lift function corresponding to a sudden unit change of incidence can be derived from the lift function corresponding to simple harmonic translational motion. From results given for rectangular wings and tapered wings in simple harmonic motion, corresponding values of the lift function are determined. The growth of lift function for a wing penetrating a uniform vertical gust can then be estimated. By the use of approximate formulas for the growth of lift curves, the aerodynamic forces corresponding to damped and growing translational oscillations are derived.

Downwash Behind Wings of Finite Span. E. Goossens. *Aircraft Engineering*, Vol. 19, No. 222, August, 1947, pp. 244–248, figs. 7 references.

A method of calculating the down-wash velocity and the down-wash angle caused by the system of "porter" and free vortexes. The angle of down-wash can be computed for any value of height or distance in the symmetry plane and the elliptical load distribution calculated. It is necessary to find only four elliptic integrals in the elliptic-integral table, the moduli of which can be easily calculated. By analogy, it is possible to calculate the general load distribution, the nonelliptical load distribution caused by flaps, and the case in which the wing is not elliptical.

High-Speed Wake Traverse Drag Measurements on a Model Spitfire Half-Wing. J. S. Thompson and W. Port. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2152*, May, 1945. 9 pp., diagrs. 2 references. British Information Services, New York. $0.60.

For comparison with flight results, wake traverse measurements have been made on a $^1/_3$-scale model of a Spitfire half-wing in the Royal Aircraft Establishment high-speed tunnel. An inclusive range from $+1°$ to $-3.7°$ was covered at Mach Numbers up to about 0.84. The drag rises steeply above $M=0.75$, and at the same time the incidence of minimum drag, which is about $+1°$ at low speeds, decreases to between $-1°$ and $-2°$. The drag rise is largely due to the direct loss through the wing shock, which has been assessed separately by analyzing the wake shapes. No comparable results are at present available from flight tests.

Experimental and Calculated Characteristics of Three Wings of NACA 64-210 and 65-210 Airfoil Sections With and Without 2° Washout. James C. Sivells. *U.S., N.A.C.A., Technical Note No. 1422*, August, 1947. 17 pp., diagrs. 3 references.

Three wings of aspect ratio 9 and with a root chord to tip chord ratio of 2.5 were tested. The effect of changing the airfoil section from an NACA 65–210 to an NACA 64-210 section was to increase the maximum lift coefficient by about 10 per cent. The abruptness of the stall was also increased. The addition of 2 per cent washout to the NACA 65-210 wing increased the angle of attack for zero lift as expected but was not sufficient to improve materially the stalling characteristics.

An Application of Lifting-Surface Theory to the Prediction of Angle-of-Attack Hinge-Moment Parameters for Aspect Ratio 4.5 Wings. Arthur L. Jones, Mildred C. Flanagan, and Loma Sluder. *U.S., N.A.C.A., Technical Note No. 1420*, September, 1947. 16 pp., illus. 6 references.

Low-Speed Static Stability and Damping-in-Roll Characteristics of Some Swept and Unswept Low-Aspect-Ratio Wings. Louis P. Tosti. *U.S., N.A.C.A., Technical Note No. 1468*, October, 1947. 24 pp., diagrs. 12 references.

Results of an investigation to determine the static longitudinal stability, directional stability, effective dihedral, and damping-in-roll of some low-aspect-ratio wings. Eighteen wings having different aspect ratios, taper ratios, and sweepback angles were used. Most of the wings were of aspect ratios $\geqq 3$, although four wings of higher aspect ratios were included for comparison.

Pressure and Wake Measurements up to Mach Number 0.85 on an EC 1250 Section with 25 Per Cent Control. J. A. Beavan, G. A. M. Hyde, and R. G. Fowler. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2065*, February, 1945. 46 pp., figs. 17 references. British Information Services, New York. $2.40.

A two-dimensional airfoil model of the low-drag Section EC 1250, having the rear 25 per cent movable as a control, was pressure-plotted in the 20-in. by 8 in. rectangular high-speed tunnel up to the highest Mach Number that could be reached, usually $M = 0.85$. The chief value of the results is considered as giving an understanding from the pressure distributions of certain aspects of the behavior of the forces which are of general importance. The two-dimensional nature of the tests and the not very practical airfoil section, with its convex control, to a certain extent hinder the direct use of the results in current practice.

Minimum Velocity Aerofoils. L. G. Whitehead. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No.*

The irregularity of receipt of publications from abroad necessitates the review of articles in issues several months late. This is done to provide readers with information regarding foreign technical progress as soon as the issues are available in the United States.

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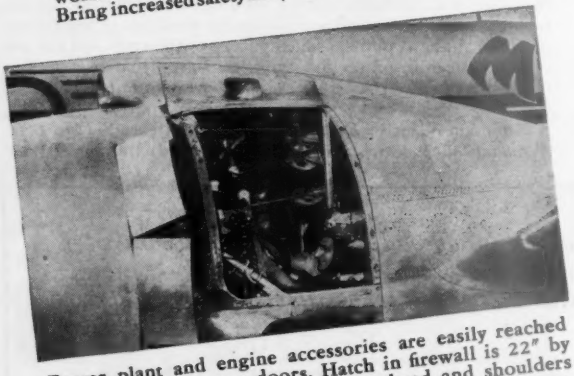

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2161, August, 1942. 12 pp., diagrs. 4 references. British Information Services, New York. $0.75.

The methods of free streamline theory are used to design airfoil sections that give the least increase of velocity for a chosen thickness ratio. The resulting profiles, which include both symmetrical and simple cambered sections, indicate the general features that are required in designs to delay the onset of shock waves at high speeds.

Flight Tests of Beveled-Trailing-Edge Ailerons with Various Modifications on a North American XP-51 Airplane (AAF No. 41-38). Maurice D. White and Herbert H. Hoover. *U.S., N.A.C.A., Memorandum Report (Wartime Report No. L-550)*, December, 1943. 55 pp., illus. 3 references.

The Smallest Size of a Spanwise Surface Corrugation Which Affects Boundary-Layer Transition on an Aerofoil. A. Fage. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2120*, January, 1943. 19 pp., figs. 7 references. British Information Services, New York. $1.05.

Wind-tunnel experiments made with bulges, hollows, and ridges on an airfoil and on a flat plate showed that the height, rather than the form, of the corrugation is significant. The rising and falling velocity gradients associated with a corrugation that just affects transition are numerically large compared with the beneficial velocity gradient on a smooth laminar-flow airfoil. Measurements of normal pressure on the surface indicated that the flow conditions near a corrugation that affects transition position are associated with a separation of the laminar boundary layer from its surface.

The Design of Suction Aerofoils with a Very Large C_L-Range. M. B. Glauert. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2111*, November, 1945. 8 pp., figs. 2 references. British Information Services, New York. $0.70.

A comparison of four airfoils that have a coefficient of lift ranging from 0. to 2.0 and a thickness of about 30 per cent. The design is in accordance with Lighthill's exact theory which prescribes the velocity over the surface as a function of position on a circle into which the airfoil may be transformed. The region of falling velocity over the rear part of the airfoil is replaced by a single discontinuity in velocity. At this point boundary-layer suction is applied to eliminate adverse pressure gradients throughout a wide range of incidence. At the discontinuity the mathematical shape is a logarithmic spiral modified to include the suction slot. From comparison it appears that thick suction airfoils have low critical Mach Numbers. The airfoils are designated as GLAS I, II, III, and IV.

A New Method of Two-Dimensional Aerodynamic Design. M. J. Lighthill. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2112*, April, 1945. 53 pp., figs. 2 references. British Information Services, New York. $3.00.

Description and illustration of a fairly simple exact method by which airfoils and other surfaces may be constructed to have desired velocity distributions. Shapes already constructed are described in appendixes and figures.

Volterra's Solution of the Wave Equation as Applied to Three-Dimensional Supersonic Airfoil Problems. Max A. Heaslet, Harvard Lomax, and Arthur L. Jones. *U.S., N.A.C.A., Technical Note No. 1412*, September, 1947. 77 pp., illus. 13 references.

In order to develop a generalized theory that will apply to any boundary conditions likely to be met with in problems of wing theory, advantage has been taken of the direct analogy that exists between the linearized partial differential equation for supersonic flow in three dimensions and the two-dimensional wave equation. Solutions given for the wave equation are shown to fulfill the boundary conditions met in wing problems. Using acceleration potentials, this method is applied to flat surfaces and to plan forms over which the loadings are assumed to be constant. From constantly loaded surfaces, surfaces having arbitrary load distributions are developed.

Wind-Tunnel Investigation of Drooped Ailerons on a 16-Percent-Thick Low-Drag Airfoil. Ralph W. Holtzclaw and Jules B. Dods, Jr. *U.S., N.A.C.A., Technical Note No. 1386*, August, 1947. 69 pp., illus. 10 references.

Tests made with airplanes having spans of from 45 ft. to 141 ft. show that the drooped aileron is a practicable lateral control device. The adverse yaw caused by full aileron deflection should not be sufficient to produce excessive angles of sideslip or to render the rudder incapable of trimming the airplane to zero sideslip. The hinge-moment coefficient reversal exhibited by the normal profile aileron necessitated another design with a modified nose shape. The profile was made straight-sided to reduce the value of the aileron section hinge-moment coefficient. The effectiveness of the drooped aileron was seriously reduced when the aileron was positioned for minimum drag rather than maximum lift.

Effects of Mean-Line Loading on the Aerodynamic Characteristics of Some Low-Drag Airfoils. Milton Davidson and Harold R. Turner, Jr. *U.S., N.A.C.A., Advance Confidential Report No. 3127 (Wartime Report No. L-699)*, September, 1943. 18 pp., figs. 4 references.

Linearized Theory of Supersonic Control Surfaces. P. A. Lagerstrom and Martha E. Graham. *Douglas Aircraft Co., Inc., Report No. SM-13060*, July 24, 1947. 49 pp., figs. 6 references.

The pressure distribution induced by the deflection of a control surface and the lift and centers of pressure of the aileron are calculated by the linear nonviscous theory of supersonic flow. The solution is first obtained for the entire plan form with the flap undeflected, and on it is superimposed the solution for the deflected aileron. The second solution considers the aileron to be an independent wing with an angle of attack equal to the angle of deflection. The Busemann solution is used for the tip Mach cones where applicable. A special solution is developed for that tip cone that contains a portion of the deflected aileron and a portion of the wing. The case of a rectangular wing with rectangular aileron is used to introduce the method, which is then applied to the sweptback trapezoidal wing, the wide triangular wing, and the narrow triangular wing. The details of the calculations of lift and center of pressure for the cases considered are given in the appendix. The plan forms that were selected illustrate how the method is used and show that to a large extent the results are independent of the plan form of the wing.

Wind-Tunnel Investigations on a Changed Mustang Profile with Nose Flap: Force and Pressure-Distribution Measurements. W. Krüger. *(Göttingen, ZWB/UM/3153*, September 22, 1944.) *U.S., N.A.C.A., Technical Memorandum No. 1177*, September, 1947. 18 pp., diagrs. 7 references.

Force and pressure distribution measurements on a rectangular modified Mustang wing equipped with nose and split flaps were made in the large wind tunnel of the AVA to investigate the improvement of maximum lift coefficient obtainable by use of nose flaps. Nose flap chords of $0.50c$ and $0.10c$ were investigated for various values of nose-flap angle and curvature at the leading edge of the nose flap.

The High-Speed Characteristics of Several Flaps and Spoilers on the Upper Surface of the Horizontal Stabilizer of a Model of a Radial-Engine Pursuit Airplane. Lee E. Buddy. *U.S., N.A.C.A., Memorandum Report No. A5L07 (Wartime Report No. A-72)*, January, 1946. 187 pp., illus. 5 references.

Any of the devices tested which had a projected area normal to the stabilizer surface of approximately 2 per cent of the horizontal tail area were sufficiently powerful to provide satisfactory recovery from a dive at Mach Number 0.815. The acceleration available from the flaps decreased rapidly with increased Mach Number above the Mach Number at which the pitching-moment characteristics of the model diverged. The flaps were not satisfactory as a longitudinal trim device because of a reversal of their effectiveness for small deflections and their detrimental effect upon the elevator-free stability of the model. The flaps were not powerful enough to replace the elevators as a longitudinal control device.

Investigation of a Spoiler-Type Lateral Control System on a Wing with Full-Span Flaps in the Langley 19-Foot Pressure Tunnel. Owen J. Deters and Robert T. Russell. *U.S., N.A.C.A., Technical Note No. 1409*, August, 1947. 53 pp., illus. 5 references.

Various modifications and arrangements of the wing and spoiler were made. The initial stalling of the wing occurred at the tips with the vent located directly behind the spoiler, open or closed, when the full-span flaps were deflected. The simultaneous operation of the spoiler and vent in contrast to a vent fixed in the wing should result in a large increase in the effectiveness of the spoiler and should eliminate any loss in wing lift. The spoiler perforations reduced the rolling-moment and yawing-moment coefficients to become more positive. Progressively decreasing the spoiler span by removing the segments from the inboard end of the spoiler caused a decrease in rolling effectiveness approximately proportional to the span of the segment.

At the Baltimore plant of The Glenn L. Martin Company, a General Electric Service Engineer and a Martin representative inspect the new G-E high-tension ignition system on a 2-0-2. This system, revised from the warplane version, will be used on many of the new airline planes. Northwest Airlines has requested it for the 2-0-2s they propose to fly. It will also be used on many of the Martin 3-0-3s, the twin-engine cabin-pressurized airliner soon to enter service.

This ignition system, used on Pratt & Whitney engines in such planes as the C-46 and the P-47 during the war, has been modified for the new R-2800CA engine powering the 2-0-2. Its long service record, plus the fact that it requires little or no maintenance between engine overhaul periods, made it a logical choice for commercial planes.

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Comparison of the Control-Force Characteristics of Two Types of Lateral-Control System for Large Airplanes. Owen J. Deters. *U.S., N.A.C.A., Technical Note No. 1441*, September, 1947. 25 pp., diagrs. 6 references.

Contains an analysis of the control-force characteristics and rolling effectiveness of a spring-tab control system and a spoiler pilot-aileron control system. A comparison of the two systems indicated, in general, that at high speeds the spring-tab aileron would provide slightly greater rolling effectiveness for smaller control forces than would the spoiler system but that at low speeds the spoiler pilot-aileron system would give much larger values of rolling effectiveness for a given value of control force.

Wind-Tunnel Tests of Ailerons at Various Speeds. *U.S., N.A.C.A.*

I—Ailerons of 0.20 Airfoil Chord and True Contour with 0.35 Aileron-Chord Extreme Blunt Nose Balance on the NACA 66,2-216 Airfoil. W. Letko, H. G. Denaci, and C. Freed. *Advance Confidential Report No. 3F11 (Wartime Report No. L-431)*, June, 1943. 44 pp., illus. 2 references.

IV—Ailerons of 0.20 Airfoil Chord and True Contour with 0.35 Aileron-Chord Extreme Blunt-Nose Balance on the NACA 23012 Airfoil. W. Letko, T. A. Hollingsworth, and R. A. Anderson. *Advance Confidential Report No. 3H28 (Wartime Report No. L-433)*, August, 1943. 47 pp., illus. 8 references.

V—Pressure Distributions over the NACA 66,2-216 and NACA 23012 Airfoils with Various Balances on 0.20-Chord Ailerons. W. Letko and H. G. Denaci. *Advance Confidential Report No. 3K05 (Wartime Report No. L-434)*, November, 1943. 47 pp., illus. 5 references.

Wind-Tunnel Investigation of Ailerons on a Low-Drag Airfoil. III—The Effect of Tabs. Ralph W. Holtzclaw and Robert M. Crane. *U.S., N.A.C.A., Advance Confidential Report No. 4H15 (Wartime Report No. A-18)*, November, 1944. 40 pp., figs. 6 references.

High-Speed Wind-Tunnel Tests of an NACA 0009-64 Airfoil Having a 33.4-Percent-Chord Flap with an Overhang 20.1 Percent of the Flap Chord. David B. Stevenson and Alfred A. Adler. *U.S., N.A.C.A., Technical Note No. 1417*, September, 1947. 33 pp., illus. 10 references.

Investigation of the Aileron and Tab of a Spring-Tab Lateral-Control System in the Langley 19-Foot Pressure Tunnel. Owen J. Deters and Robert T. Russell. *U.S., N.A.C.A., Technical Note No. 1431*, September, 1947. 34 pp., illus. 1 reference.

Wind-Tunnel Investigation of a Plain Aileron with Various Trailing-Edge Modifications on a Tapered Wing. II—Ailerons with Thickened and Beveled Trailing Edges. III—Ailerons with Simple and Spring-Linked Balancing Tabs. F. M. Rogallo and Paul E. Purser. *U.S., N.A.C.A., Advance Restricted Reports (Wartime Reports Nos. L-228, L-470)* October, 1942, January, 1943. 26, 28 pp., diagrs. 4, 7 references.

Investigation of NACA 65(112)A111 (Approx.) Airfoil with 0.35-Chord Slotted Flap at Reynolds Numbers up to 25 Million. Stanley F. Racisz. *U.S., N.A.C.A., Technical Note No. 1463*, October, 1947. 33 pp., illus. 4 references.

Test of NACA 66,2-116, a = 0.6 Airfoil Section Fitted with Pressure Balance and Slotted Flaps for the Wing of the XP-63 Airplane. William J. Underwood and Frank T. Abbott, Jr. *U.S., N.A.C.A., Memorandum Report (Wartime Report No. L-701)*, May, 1942. 19 pp., figs. 1 reference.

Wind-Tunnel Investigation of an NACA Full-Span High-Lift Lateral-Control Combination. I—Section Characteristics, NACA 23012 Airfoil. F. M. Rogallo and John G. Lowry. *U.S., N.A.C.A., Advance Restricted Report (Wartime Report No. L-288)*, July, 1942. 30 pp., diagrs. 14 references.

Wind-Tunnel Investigation of Control-Surface Characteristics. *U.S., N.A.C.A.*

VI—A 30-Percent-Chord Plain Flap on the NACA 0015 Airfoil. Richard I. Sears and Robert B. Liddell. *Advance Restricted Report (Wartime Report No. L-454)*, June, 1942. 23 pp., diagrs. 8 references.

X—A 30 Percent-Chord Plain Flap with Straight Contour on the NACA 0015 Airfoil. H. Page Hoggard, Jr. *Advance Restricted Report (Wartime Report No. L-366)*, September, 1942. 16 pp., diagrs. 9 references.

XV—Various Contour Modifications of a 0.30-Airfoil-Chord Plain Flap on an NACA 66(215)014 Airfoil. Paul E. Purser and John M. Riebe. *Advance Confidential Report No. 3L20 (Wartime Report No. L-668)*, December, 1943. 42 pp., diagrs. 10 references.

XVII—Beveled-Trailing-Edge Flaps of 0.20, 0.30, and 0.40 Airfoil Chord on an NACA 0009 Airfoil. Vernard E. Lockwood. *Advance Confidential Report No. L4D12 (Wartime Report No. L-666)*, April, 1944. 53 pp., diagrs. 7 references.

Modern Application of the Handley Page Slot. *Handley Page Bulletin*, Vol. 13, No. 150, August, 1947, pp. 3–6, diagrs.

Flutter Tests of B-34 Fin-Rudder-Tab System. Theodore Theodorsen and N. H. Smith. *U.S., N.A.C.A., Memorandum Report (Wartime Report No. L-679)*, September, 1944. 23 pp., illus.

High-Speed Tunnel Measurements of Fin-Tailplane Interference between EC 1040 and EC 1240 Sections. W. F. Hilton, S. J. Moore, and R. F. Sargent. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2138*, May, 1941. 7 pp., figs. British Information Services, New York. $0.55.

The addition of a fin to an airfoil to represent a tailplane causes a loss of lift and an increase in drag coefficient at Mach Numbers between 0.25 and 0.825. This effect can be avoided if the maximum suctions on the fin and on the tailplane coincide and the fin is put either well forward or well aft of the tailplane. An alternative method is to fair the fin-tailplane junction by a streamline body of revolution.

Stalling Phenomenon and the Tailless Aeroplane. VII. A. R. Weyl. *The Aeroplane*, Vol. 73, No. 1888, August 15, 1947, pp. 190–192, illus. 85 references. (Cf. AER 11/47:29.)

An historical summary of the development of the swept-forward and the low-aspect-ratio wing. The performance of these types in stall is estimated to show their applicability to tailless aircraft. The list of references contains some allusion to compressibility stall in addition to tailless airplane problems.

A Comparison at High Speed of the Aerodynamic Merits of Models of Medium Bombers Having Thickened Wing Roots and Having Wings with Nacelles. Eugene C. Draley. *U.S., N.A.C.A., Advance Confidential Report No. 3L03 (Wartime Report No. L-390)*, December, 1943. 27 pp., illus. 3 references.

Searching Drag Studies Check Speed Impeders. VIII. *Aviation Week*, Vol. 47, No. 14, October 6, 1947, p. 26, diagrs. (Cf. AER 11/47:25.) Two examples of canopy modification and three examples of antenna installations are analyzed to show drag characteristics.

Effects of External Fuel Tanks and Bombs on Critical Speeds of Aircraft. S. Katzoff and Robert S. Finn. *U.S., N.A.C.A., Confidential Bulletin No. L5H27 (Wartime Report No. L-726)*, February, 1946. 16 pp., diagrs. 9 references.

Aerodynamic Characteristics of a 4-Engine Monoplane Showing Comparison of Air-Cooled and Liquid-Cooled Engine Installations. Abe Silverstein and Herbert A. Wilson, Jr. *U.S., N.A.C.A., Advance Confidential Report (Wartime Report No. L-471)*, July, 1939. 26 pp., illus. 4 references.

Investigation of Flow in an Axially Symmetrical Heated Jet of Air. Stanley Corrsin. *U.S., N.A.C.A., Advance Confidential Report No. 3L23 (Wartime Report No. W-94)*, December, 1943. 55 pp., illus. 11 references.

Fourth Test Report on the Investigation of the Airflow on a Turbine Blade by Means of the Interference Method. von Vietinghoff-Scheel. *(Luftfahrtforschungsanstalt Hermann Göring, UM 2018*, July, 1943.) *U.S., Army Air Forces, Translation No. F-TS-3232-RE*, August, 1947. 6 pp., illus.

The pitch ratio (outer diameter-pitch) at the blade root was 0.614. No considerable flow losses were observed at the pitch ratio 0.593 with angles of attack of 20° through 90° and Reynolds Numbers 10^5 to 2.10^5. The most favorable flow conditions were found to be at an angle of attack of 26.5°. On a blade grid consisting of sections with a thick trailing edge, an excessive negative angle occurs which must be taken into consideration in the design of blades arranged in sequence.

Tests of Cascades of Airfoils for Retarted Flow. Yoshinori Shimoyama. *(Society of Mechanical Engineers of Japan, Transactions*, Vol. 3, No. 13, November, 1937, pp. 334–344.) *U.S., N.A.C.A., Technical Memorandum No. 1190*, October, 1947. 28 pp., illus. 13 references.

Wind-tunnel tests were made on cascades of airfoils in retarded flow and with increasing pressure. These conditions correspond to the case of the impeller of an axial propeller pump and the case of a propeller fan. The results are charted and explained in detail. Results of tests on a single airfoil are compared with lift and pressure-drag coefficients obtained from tests on center sections of five-, seven-, and nine-section cascades.

Method of Designing Vaneless Diffusers and Experimental Investigation of Certain Undetermined Parameters. W. Byron Brown and Guy R. Bradshaw. *U.S., N.A.C.A., Technical Note No. 1426*, September, 1947. 37 pp., illus. 6 references.

The rate of expansion of the flow area through the diffuser was found in terms of an equivalent cone laid off along the logarithmic spiral that had an angle equal to that for the optimum flow condition of the impeller. Five vaneless diffusers incorporating three different cone angles and three different throat heights were used to determine this optimum condition experimentally. Better compressor efficiencies were obtained than those of the vaned diffuser designed for this impeller, without affecting the wide operating-range characteristic of the vaneless diffuser.

Calculation of Diffuser Efficiency for Two-Dimensional Flow. R. C. Binder. *Journal of Applied Mechanics*, Vol. 14, No. 3, September, 1947, pp. A-213–A-216, figs. 6 references.

A method that employs a combination of organized boundary-layer data and frictionless potential-flow relations. The potential velocity and pressure are found after the boundary-layer growth is determined by a trial-and-check calculation.

A Comparison of Three Spinner-Diffuser Designs in an NACA D_S Cowling for the Pratt & Whitney R-2800 Engine. Louis W. Habel and Peter F. Korycinski. *U.S., N.A.C.A., Memorandum Report* (*Wartime Report No. L-579*), June, 1944. 38 pp., illus. 4 references.

Cascade Investigation of Buckets for a Modern Aircraft Turbosupercharger. Arthur Kantrowitz and John R. Erwin. *U.S., N.A.C.A., Advance Confidential Report No. L4J25* (*Wartime Report No. L-765*), November, 1944. 23 pp., illus. 1 reference.

An Experimental Survey of Flow Across Banks of Elliptical and Pointed Tubes. Upshur T. Joyner and Carl B. Palmer. *U.S., N.A.C.A., Advance Restricted Report* (*Wartime Report No. L-609*), January, 1943. 31 pp., diagrs. 2 references.

The Turbulent Flow in Diffusers of Small Divergence Angle. G. A. Gurzhenko. (*Tsentral'nyi Aero-Gidrodinamicheskii Institut* (*Moscow*), *Trudy No. 462*, 1939.) *U.S., N.A.C.A., Technical Memorandum No. 1137*, October, 1947. 77 pp., figs. 4 references.

Formulas are derived for computing velocity and pressure distributions in the turbulent flow along, and perpendicular to, the axis of a diffuser of small cone angle. Measured velocity and pressure distributions in two conical diffusers with angles of 1° and 2° are compared with theoretical values. A first approximate attempt is made at estimating semiempirically the deviation of the true motion from the radial pattern assumed.

Investigation of the Pressure-Loss Characteristics of a Turbojet Inlet Screen. John L. Lankford. *U.S., N.A.C.A., Technical Note No. 1418*, September, 1947. 25 pp., illus.

A screen that consisted of 31 circular vanes supported by twelve radial struts was tested in two configurations. In one the vane leading edges were square and rough and in the other they were rounded. Pressure losses increased rapidly with increasing weight flow. Slight radial and circumferential variations were present downstream of the screen. Rounding the vane leading edges reduced static-pressure losses considerably and produced slight improvements in the total-pressure patterns.

Tests of High-Speed Flow in Right-Angled Pipe Bends of Rectangular Cross-Section. A. D. Young, G. L. Green, and P. R. Owen. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2066*, October, 1943. 28 pp., illus. 4 references. British Information Services, New York. $2.40.

The tests covered measurements of the losses involved, of the pressure distributions around the bends, and shadowgraph observations of the flow patterns and shock waves in the bends. A range of bend radii, as well as a range of aspect ratios of the cross-sectional shapes, was covered. In each case the investigation was carried from low entry Mach Numbers up to, and beyond, the point at which the pipe bend "choked." The main conclusions from these tests are that (1) for a given cross-sectional area and radius of the centerline of the bend, the most efficient shape for a rectangular cross-section at high entry Mach Numbers is square; (2) if the radius of such a bend is fairly gentle (e.g., 4-in. radius for 2-in. square cross section), the increase in bend losses with increase in entry Mach Number is small up to the entry Mach Number at which the bend chokes; and (3) the losses remain constant for further increase in the entry stagnation pressure after the bend has choked.

Drag and Size of Air Scoops. Hoerner. (*Oberammergau, Oberbayerische Forschungsanstalt, Me/Ge/299*, January, 1945.) *U.S., Army Air Forces, Translation No. F-TS- 2623-RE*, August, 1947. 22 pp., diagrs. 3 references.

The theory of internal flow in its application to coolers is developed for the case of ventilation. The drag of the intake scoop was found always to be positive. The drag of exhaust scoops, under conditions of low internal drag, was found to be negative. The rate and volume of flow depend on the internal drag and the outlet cross section. Measurements made of five differently shaped scoops show that the intake scoop must be strongly rounded and that the orifice of the outlet scoop must be tangent to the surface in which it is located and approximately twice as large as the intake scoop.

High-Speed Investigation of Low-Drag Wing Inlets. Norman F. Smith. *U.S., N.A.C.A., Advance Confidential Report No. L4I18* (*Wartime Report No. L-732*), September, 1944. 70 pp., illus. 3 references.

Some Lift and Drag Measurements of Two Configurations of a Nacelle and Oil-Cooler Scoop for the Hughes-Kaiser Cargo Airplane. John H. Quinu. *U.S., N.A.C.A., Memorandum Report* (*Wartime Report No L-748*), September, 1943. 13 pp., diagrs. 4 references.

Development of Wing Inlets. Stanley F. Racisz. *U.S. N.A.C.A., Advance Confidential Report No. L6B18* (*Wartime Report No. L-727*), March, 1946. 47 pp., illus. 3 references.

Wind-Tunnel Investigation of Wing Ducts on a Single-Engine Pursuit Airplane. W. J. Nelson and K. R. Czarnecki. *U.S., N.A.C.A., Advance Restricted Report No. 3J13* (*Wartime Report No. L-407*), October, 1943. 46 pp., illus. 6 references.

Flight Investigation of NACA D_S Cowlings on the XP-42 Airplane. III—Low-Inlet-Velocity Cowling Without Fan or Propeller Cuffs, with Axial-Flow Fan Alone, and with Two Different Sets of Propeller Curves. IV—High-Inlet-Velocity Cowling Tested in Climb with and Without Propeller Cuffs and in High-Speed Level Flight Without Propeller Cuffs. J. Ford Johnston and T. J. Voglewede. *U.S., N.A.C.A., Advance Restricted Reports* (*Wartime Reports Nos. L-508, L-285*), January, 1943. 51, 23 pp., figs. 3, 4 references.

Investigation of the Operating Properties of the Leakage Current Anemometer. Wilhelm Fucks. (*ZWB/UM/1203*, February 4, 1944.) *U.S., Technical Memorandum No. 1178*, October, 1947. 73 pp., illus. 3 references.

Earlier apparatus using the leakage current for the measurement of flow velocities in gases has been improved by reducing the size of the electrodes by one one-thousandth and by increasing the magnitude of the current 10,000 times through the use of mercury lamps with reflectors or X-ray radiation. Families of calibration curves were obtained for the instrument, and sensitivity was calculated. Results of tests show that the leakage-current anemometer should be appropriate for investigations of turbulence.

The Use of Rheo-Electrical Analogies in Certain Aerodynamical Problems. L. Malavard. *Royal Aeronautical Society, Journal*, Vol. 51, No. 441, September, 1947, pp. 739–753, illus. Discussion, pp. 753–756. 14 references.

A description of the methods of electrical analogy developed at the French National Center of Scientific Research. The general principles of the method are illustrated by the applications that have been made to aerodynamic problems. The equipotential lines in an electrolyte are traced by an electrode probe and stylus. The use of two electrodes to determine the potential gradient makes it possible to determine the velocity field. The lines thus determined are analogous to aerodynamic lines of flow. By the use of both insulated and conductive models in the electrolyte, cascades of profiles that represent the blades of a rotor can be investigated. For the calculation of wings the electrolyte is replaced by a network of resistances connecting electrodes in pairs.

Development and Construction of an Interferometer for Optical Measurements of Density Fields. Th. Zobel. (*Deutsche Versuchsanstalt für Luftfahrt, ZWB/FB/1008*, June 30, 1938.) *U.S., N.A.C.A., Technical Memorandum No. 1184*, September, 1947. 33 pp., illus. 12 references.

Description of a method of interference and a discussion of its basic principles and a simple method of adjustment. Because of its special construction, the instrument can be used in the case of vibrations in the surrounding space and for the investigation of unsteady phenomena. With the interference method, small differences in density in the flow field around bodies can be measured optically at speeds as low as 40 meters per min.

Beechcraft Model 34 Twin-Quad, new 20-passenger short-haul transport, made its initial flight October 1.

Air Transport

Today's Problem of an Airline Operator. J. W. Booth. *Institute of Transport, Journal*, Vol. 22, No. 13, July-August, 1947, pp. 489–495.

Société Nationale Air France (Air France), Paris. *U.S., Civil Aeronautics Board, Airline Manual, Supplement*, October 6, 1947. 24 pp., map. 30 references.

The Airlines and the Railway Express Agency. John H. Frederick. *Distribution Age*, Vol. 46, No. 8, August, 1947, pp. 40, 48, illus.

Civil Aviation in Italy; Post-War Developments. G. M. Riggi. *Shell Aviation News (London)*, No. 110, August, 1947, pp. 7–9, illus.

An Airfreight MUST . . . Efficient Ground Service. *Distribution Age*, Vol. 46, No. 8, August, 1947, pp. 26, 27, 56–58, illus.

Airplane Descriptions

The Apollo (Armstrong Whitworth Transport Powered by 4 Propeller-Turbine Engines). *Flight*, Vol. 52, No. 2017, August, 21, 1947, p. 187, diagrs.

The Avro Athena; Merlin-Engined Version of Advanced Trainer. *Flight*, Vol. 52, No. 2018, August 28, 1947, p. 214, diagrs.

Our First Jet Trainer (Boulton-Paul P. 108). *The Aeroplane*, Vol. 73, No. 1887, August 8, 1947, p. 150, illus. Powered by a Rolls-Royce Dart or an Armstrong Siddeley Mamba turbine.

Advanced Trainer; Boulton Paul P. 108 Completes Initial Tests with Mercury Engine. *Flight*, Vol. 52, No. 2015, August 7, 1947, p. 129, illus.

The D. H. Chipmunk (Primary Trainer). *Flight*, Vol. 52, No. 2017, August 21, 1947, pp. 183–186, cutaway diagrs.

The Douglas DC-6. *The Aeroplane*, Vol. 73, No. 1887, August 8, 1947, pp. 166, 167, 168, illus.

Hughes XF-11 to Test Photo Plane Worth; Wright Field to Take Delivery on First Plane Designed Specifically for Purpose; Features High Speed. *Aviation Week*, Vol. 47, No. 15, October 13, 1947, pp. 23, 24, 27, illus.

The Ilyushin IL-12 (Russian 2-Engine Transport). *The Aeroplane Spotter*, Vol. 8, No. 194, August 23, 1947, p. 189, illus.

Data on the Messerschmitt "108" Taifun Fighter. Richard G. Naugle. *Western Flying*, Vol. 27, No. 10, October, 1947, pp. 24, 26, illus.

Miles Merchantman; Four-Engined Pantechnicon with Two-Ton Payload: Robust Simplicity. *Flight*, Vol. 52, No. 2018, August 28, 1947, pp. 221–225, cutaway diagrs. (Cf. AER 11/47:29.)

Swept Wing (North American) XP-86 Readied for Flight. *Aviation Week*, Vol. 47, No. 14, October 6, 1947, p. 14, illus.

Republic Seabee in the Air; An Opinion of Its Performance Off Land and Water. *Flight*, Vol. 52, No. 2016, pp. 160–162, illus.

For Empire Routes; Features of the Short Solent-Class Flying-Boats for B.O.A.C. *Flight*, Vol. 52, No. 2017, August 21, 1947, pp. 193–196, cutaway diagrs.

Tipsy Junior; Advanced Performance of Diminutive Single-Seater on 60 Hp. *Flight*, Vol. 52, No. 2014, July 31, 1947, p. 115, illus. (Cf. AER 11/47:29.)

Two New Italian Aeroplanes (The Alparma Tucano Ultra-Light Airplane and the Ambrasini Grifo G.1001 Personal Airplane). *The Aeroplane*, Vol. 73, No. 1890, August 29, 1947, p. 240, illus.

British Show Spurs New Export Drive; Wide Range of Military and Civil Aircraft Types Impresses Foreign Visitors. Frederick R. Brewster. *Aviation Week*, Vol. 47, No. 14, October 6, 1947, pp. 21, 22, 25, illus.

Airplane Design

Useful Load Ratio with Jet and Airscrew Propulsion of Aircraft. K. O. Lundberg. *Royal Aeronautical Society, Journal, Vol. 51, No. 440*, August, 1947, pp. 686–703, figs.

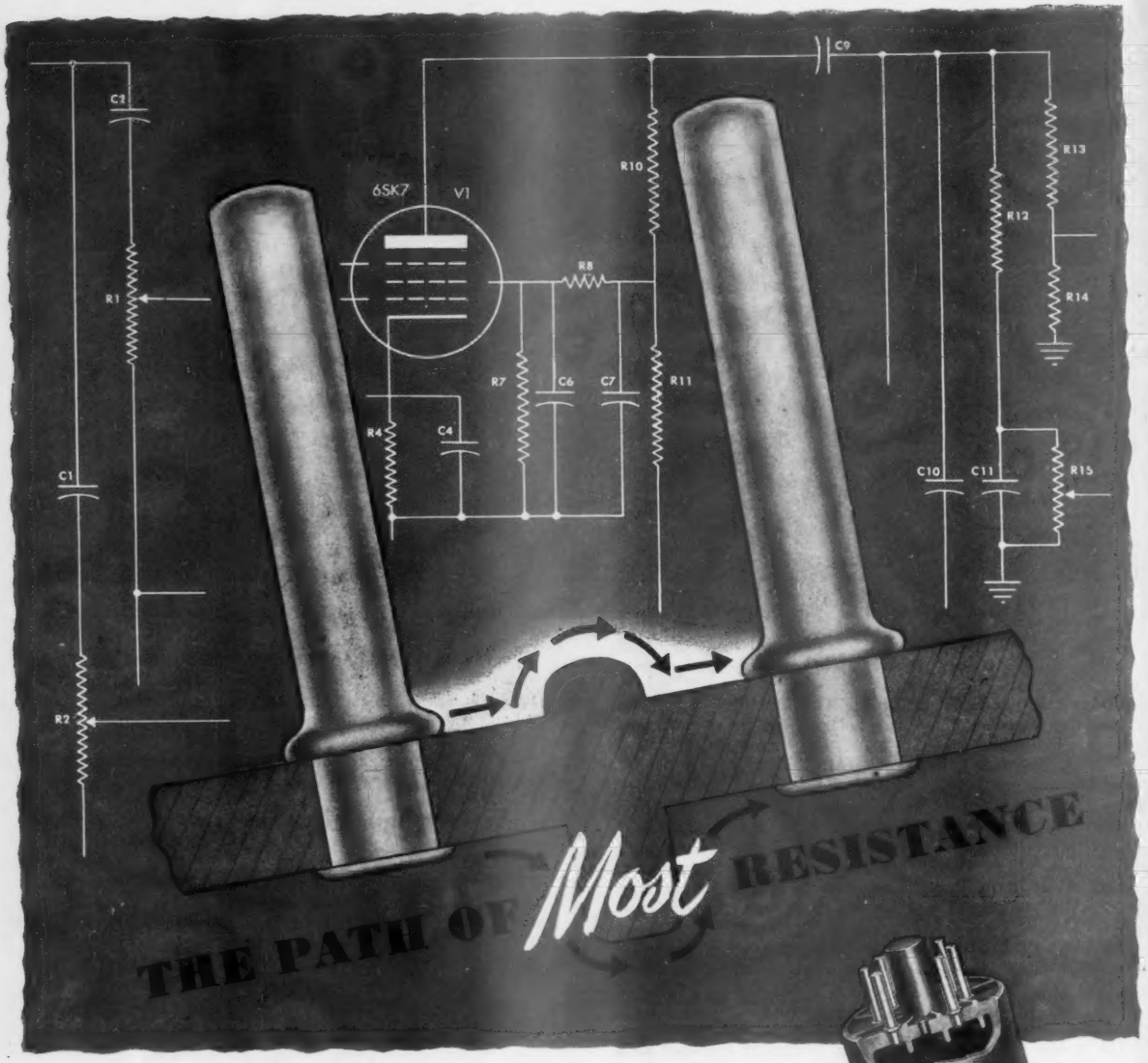
All major design parameters can be represented by the ratio between the useful load and the gross weight when considered with respect to the speed. General equations for this relationship are used to compare the efficiency of aircraft power plants. Pure jet propulsion is shown to be superior to the conventional systems at speeds as low as 200 m.p.h.

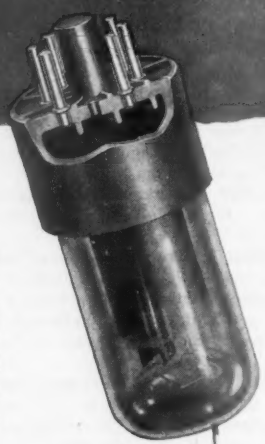
A New Ideal; What Are the Prospects of a Good British Executive Aircraft? Sir Roy Fedden. *Flight*, Vol. 52, No. 2018, August 28, 1947, pp. 215–218, diagrs.

The cost, comfort, and performance specifications that are to be desired in an aircraft for the executive market can be met by development of proper engine designs. The thermal efficiency of the engine must be improved, and the engine must be relocated to eliminate the inefficiency of the conventional engine nacelle. The propellers must be so placed as to give central thrust for single- and multiple-engined operation.

Design for Profit. H. G. Lesley. *Air Transport*, Vol. 5, No. 9, September, 1947, pp. 28–30. A survey of the design features that should be adopted for passenger cabin interiors in order to reduce cleaning and maintenance time and operating costs.

Trends in Personal Aircraft and Private Flying. Fred E. Weick and James K. Nagamatsu. *Western Flying*, Vol. 27, No. 10, October, 1947, pp. 28, 30.





AT high altitudes ordinary electron tubes can develop electrical "leaks" between the base pins. Honeywell recognized this detail as a vulnerable point in dependable aircraft operation—and did something about it! We designed a special tube base with barriers between pins, both inside and outside the base, to create a longer "leakage path"—safe resistance for higher altitudes, a feature of the Honeywell electronic Fuel Gage, Turbo-supercharger Regulator and Autopilot.

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CREATIVE ENGINEERING

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CONTROL SYSTEMS

Makers of the Famous M-H Electronic Autopilot Standard on All AAF 4-Engined Bombers

Flying Wing Has Novel Cockpit Layout. *Aviation Week*, Vol. 47, No. 15, October 13, 1947, p. 33, illus.

A description of the disposition of instruments and controls in the Northrop B-35 Flying Wing to show the utilization of the limited space in the pilot's overwing bubble and the copilot's station behind the wing leading edge.

Design and Psychology; Relationship of Cockpit Layout and Instrument Representation to Human Error and Safety. *Flight*, Vol. 52, No. 2016, August 14, 1947, pp. 170–172, illus.

Business and Finance

Survey Analyzes a Two Billion Dollar Market. *Aviation Week*, Vol. 47, No. 17, October 27, 1947, pp. 7, 26, 27, figs.

A survey made by *Aviation Week* of the market of the aeronautical manufacturing industry. Bar graphs are given to show a detailed breakdown of prospective expenditures and sales during 1948.

Comfort in Aircraft

Anatomy and Statistics Aid Design of Passenger Seats. Charles W. Morris. *SAE Journal*, Vol. 55, No. 9, September, 1947, pp. 24–26, diagrs.

A summary of the anatomical and statistical data considered in designing an aircraft seat to give the passenger optimum support both in the relaxed and the erect position. In order to determine the dimensions of the seat and the details of the upholstery, statistical data on maximum, minimum, and average body measurements of both men and women and on the movements and postures of passengers was studied and are reported briefly.

Air Conditioning System for the Martin 3-0-3. P. H. Portteus. *Modern Metals*, Vol. 3, No. 7, August, 1947, pp. 14, 15, illus.

A detailed description of the air-conditioning system developed by the Stratos Corporation of Babylon, N.Y., for The Glenn L. Martin Company. An air-cycle system controls the cabin pressure, which is maintained at sea-level value up to altitudes of 10,000 ft. and is gradually decreased as the airplane climbs. At an altitude of 20,000 ft. the cabin pressure corresponds to air pressure at 8,000 ft. The refrigeration system employs the air-cycle principle and maintains the cabin temperature within the comfort zone during both hot-weather and cold-weather operation. Aluminum and magnesium alloys are used for the components.

Control Systems

Theory of Automatic Control Systems. M. Avramy Melvin. *Journal of Applied Physics*, Vol. 18, No. 8, August, 1947, pp. 704–722, diagrs.

A development of the theory of reproducing, power-amplifying systems which is based on an equivalent system of nonlinear springs with inertia and friction. The rapidity and fidelity of control of both proportional and on-off robots are studied to determine the conditions of optimum performance. Detailed analytical and graphical solutions illustrate the simple control system with proportional control in which the restoring force is linearly proportional to the deviation.

Designing Pneumatic and Electric Servos. H. Ziebolz. *Machine Design*, Vol. 19, No. 9, September, 1947, pp. 132–138, illus.

The basic servo system transforms an input signal into a pressure or force that is transformed into the output signal after traveling the required distance. The system can be expanded to include an amplifier that can increase the output signal. If indication of the output is desired at the input station, a second linkage can be used to feed a signal proportional to the output to an integrator from which a corrective signal is delivered to the input. The systems may be designed entirely with mechanical and hydraulic elements, but energy may also be transmitted electrically or by radio.

Oblique-Section Rotor for Lightweight Synchro Motor. *Product Engineering*, Vol. 18, No. 8, August, 1947, p. 102, illus, diagrs.

A low-friction voltage control and synchronous transmitter developed by the Kollsman Instrument Division of the Square D Company. This electromagnetic pick-off device can be attached directly to the pointer shaft of an instrument and will convert the reading into electric signals. Low weight and low inertia make it practicable for the measurement and control of high angular acceleration.

Automatic Flight. James L. Anast. *Machine Design*, Vol. 19, No. 9, September, 1947, pp. 116–120, illus.

A description of the electronic circuits and mechanical systems of the Automatic Flight Controller. The unit integrates the information supplied by flight instruments with preset course data and transmits directive and corrective forces to the control surfaces of the aircraft.

Plan Trans-Pacific Robot Flight Without Crew for Automatic C-54. Robert Hotz. *Aviation Week*, Vol. 47, No. 17, October 27, 1947, pp. 21, 23, diagr. A detailed account of the automatic control operations during the round-trip transatlantic flight of the U S.A.F. C-54 Robert E. Lee in September, 1947.

The Schacht Marie Salt Mine, Beendorf (Dispersal of Siemens, Berlin). R. W. Dunn, K. R. Honick, and others. *Combined Intelligence Objectives Sub-Committee, Item No. 27, File No. 25–51.* 16 pp. British Information Services, New York. $0.55.

Report of an investigation of an underground factory of the Luftfahrtgerätewerk Hakenfelde G.m.b.H. of Berlin (LGW). Descriptions are given of the K.22 Automatic Rudder Control, which operated by applying a displacement to the rudder in response to the angular displacement of the aircraft, and the K.23, which operates on the rate-rate principle. Both systems receive their data from a standard Patin compass system.

Electrical Equipment

Variable-Speed Constant-Frequency Alternator. James W. Crooks, Jr. *Electrical Engineering*, Vol. 66, No. 9, September, 1947, pp. 882–884, diagrs.

Rotation of the brushes on a d.c.-type armature by an independent constant-speed motor yields an alternating current, the frequency of which is independent of the rotational speed of the armature. The frequency is determined by the number of poles in the generator and the speed of revolution of the brushes. The output voltage is proportional to the speed of rotation of the armature.

Navy Develops Novel Airplane Lighting. *Aviation Week*, Vol. 47, No. 16, October 20, 1947, pp. 32, 35, illus.

The Naval Aero Medical Laboratory at Philadelphia is conducting experiments in identification lighting to increase the efficiency and safety of night operation. A lucite trailing edge on the elevator and rudder presents an inverted "T" marking that can be identified against a confused background of city lights. A lucite or plexiglass wing-tip trailing edge provides an illuminated surface with the appearance of an airfoil which is a practical visual reference. The use of red and ultraviolet light for cockpit and instrument illumination reduces the temporary night blindness experienced with illumination by white light.

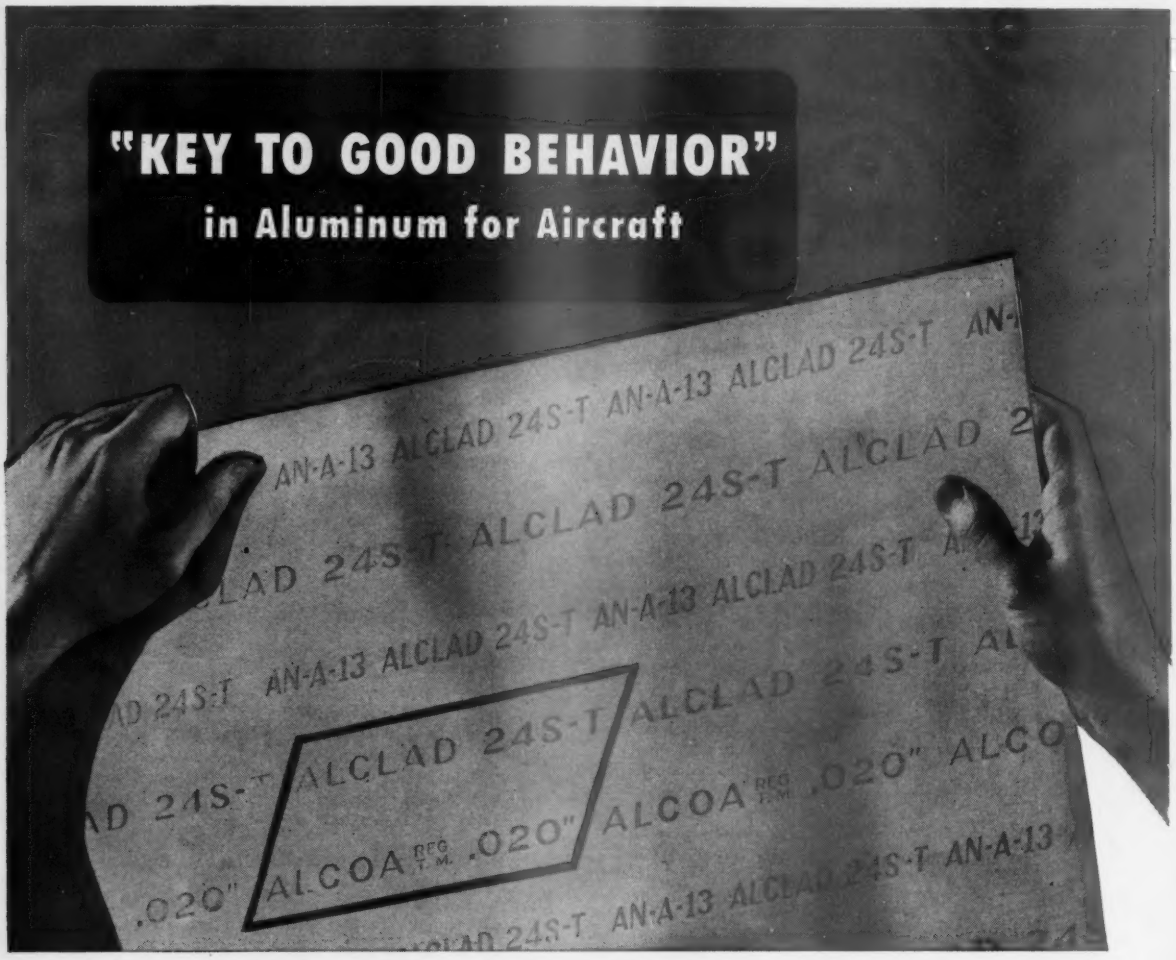
Engine Parts and Accessories

The Calculated Performance of Dynamically Loaded Sleeve Bearings, J. T. Burwell. *Journal of Applied Mechanics*, Vol. 14, No. 3, September, 1947, pp. A-231–A-245, figs. 22 references.

The general equations for film pressure and load capacity of a sleeve bearing under dynamic loading were derived by Harrison and Swift. Because of the difficulty of obtaining a general analytical solution, it was found necessary to consider cases of the various simple types of loading before calculating explicitly, by numerical methods, the journal center paths for a sinusoidal and a square-wave reciprocating loading at various frequency ratios. Some of the loadings can be expressed as analytical functions of time, while others require empirical polar load diagrams for their analysis. The method is applied to a Diesel-engine connecting-rod bearing and a radial-aircraft-engine master-rod bearing. The results can be generalized and applied to other operating conditions in which the shape of the load-time curve is the same.

Cylinder Wear Measured with a Microscope. Clarence S. Bruce and Jesse T. Duck. *SAE Quarterly Transactions*, Vol. 1, No. 3, July, 1947, pp. 448–456, illus. Discussion, p. 456.

A description of the McKee wear gage developed at the National Bureau of Standards. The surface is marked with a diamond-shaped indentation, and the length of the indentation is measured microscopically before and after wear. Wear can be computed with an accuracy of 0.00002 in. The instrument was



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used in a series of tests conducted on automobile engines. Tabulations of the wear computed at various cylinder levels and positions and under different operating temperatures and conditions indicate that cylinder wear is brought about primarily by corrosion caused by the repeated condensation of exhaust gases on the cylinder surface during warm-up.

An Introduction to an Analysis of Gas Vibrations in Engine Manifolds. R. C. Binder and A. S. Hall. *Journal of Applied Mechanics*, Vol, 14, No. 3, September, 1947, pp. A-183–A-187, diagrs. 5 references.

An introduction to, and correlation of, the mathematical techniques that may be used to analyze the vibrations of the gas in an engine manifold or exhaust system. The method is applied to a simple induction system and a specific case is worked out. The method of extending this analysis to multicylinder engines and exhaust systems is indicated.

Fuel Metering by Engine Speed and Manifold Density. Jay A. Bolt. *SAE Quarterly Transactions*, Vol. 1, No. 3, July, 1947, pp. 498–513, illus. Discussion, p. 513. (*See* AER 3/47:55.)

Crankshaft Bending Vibration. E. Forest Critchlow and W. T. Bean, Jr. *SAE Quarterly Transactions*, Vol. 1, No. 3, July, 1947, pp. 380–388, illus. (*See* AER 3/47:55.)

Sound Engine Design Thwarts Parts Fatigue. W. T. Bean, Jr. *SAE Journal*, Vol. 55, No. 9, September, 1947, pp. 44, 45, illus. (Abstract of a paper: Endurance—A Criterion of Design.)

Flight Investigation of the Performance and Cooling Characteristics of an NACA C Cowling on the XP-42 Airplane. J. Ford Johnston and Stefan A. Cavallo. *U.S., N.A.C.A., Memorandum Report (Wartime Report No. L-612)*, November, 1942. 41 pp., illus. 7 references.

Engines—General

Trends in Aircraft Engines and Propellers. K. F. Mundt, K. L. Herrmann, Charles M. Kearns, Wright A. Parkins, and Carl T. Doman. *Western Flying*, Vol. 27, No. 10, October, 1947, pp. 30, 32, 34, 36.

Symbols for Combustion Research. *Aviation Week*, Vol. 47, No. 15, October 13, 1947, pp. 29, 30. A list of 49 symbols that will be used by the N.A.C.A. in future publications. It is intended to complement other N.A.C.A. lists of symbols for specialized phases of aeronautics.

Photography in Engine Research. II—Use of the Stroboscope: Photoelasticity: Cinematography at Normal and High Speeds. H. G. Goulding. *Aircraft Production*, Vol. 9, No. 107, September, 1947, pp. 338–342, illus.

Engines, Gas Turbine

Temperatures and Stresses on Hollow Blades for Gas Turbines. Erich Pollmann. (*ZWB/FB/1879*, July 30, 1943.) *U.S., N.A.C.A., Technical Memorandum No. 1183*, September, 1947. 108 pp., illus. 9 references.

A study of the internal air cooling of turbine blades. Formulas are developed for the thermal characteristics and for the stresses produced by centrifugal force in hollow turbine blades. The calculated surface temperature distribution and the temperature field of the cross section of the blade are found to be slightly higher than the values obtained in test-stand experiments. A method is given for computing the thermal stresses in the blade. The increase in thermal efficiency obtained by increasing the temperature of the gas is shown to be in excess of the power loss introduced by the blade cooling.

Accidents with Rotating Bodies. H. Bateman. *American Journal of Physics*, Vol. 15, No. 1, January-February, 1947, pp. 36–44. 88 references.

A historical résumé of the development of the theory of the failure of rotating bodies. The work was begun originally to determine the causes of failure in fly wheels and grindstones and has been extended to the field of gas turbines and compressors. Attempts made to correlate theory with experimental results are included in the survey.

Airscrews for Gas Turbines. I. L. G. Fairhurst. *Flight*, Vol. 52, No. 2015, August 7, 1947, pp. 132–134, diagrs.

Each of the three types of propeller-gas-turbine engines (direct-connected, compounded compressor-turbine, and free turbine systems) exhibits different behavior when the propeller is used as a dive brake and as a landing brake. An analysis of these engines is made to determine the characteristics which each demands of a propeller pitch-change mechanism and the mechanical safety stops that must be included in the system to prevent overspeeding of the engine.

Fuel Atomizers for Aircraft Turbines. J. R. Joyce. *Shell Aviation News* (London), No. 110, August, 1947. pp. 17–21, diagrs.

A description of the process of atomization and the method of determining the capacity of an atomizer. The operation of the

Official U.S. Navy Photograph

The Mercator, newest Naval patrol plane built by The Glenn L. Martin Company, features two jet and two reciprocating engines, giving it a top speed in excess of 350 m.p.h.

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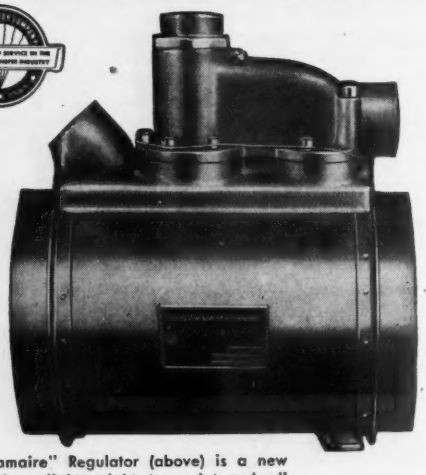

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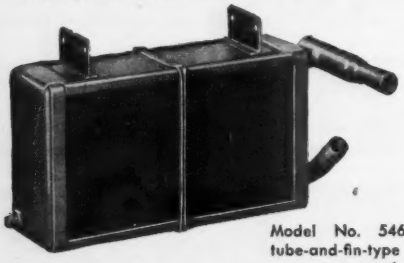

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simple, swirl-type, the spill-type, the spill-less-type, and the duplex atomizer and the injection vaporizer, basic requirements, and methods of rating performance are explained.

Thrust Augmentation Offers Power Gain. Robert McLarren. *Aviation Week*, Vol. 47, No. 16, October 20, 1947, pp. 25, 26, diagrs.

A discussion of afterburning, liquid injection, auxiliary burners, jet ejectors, and auxiliary turbojet engines to provide additional thrust to turbojet aircraft during take-off and maneuvers at high speeds and accelerations.

Blade Design Data for Axial-Flow Fans and Compressors. Seymour M. Bogdonoff and Harriet E. Bogdonoff. *U. S., N.A.C.A., Advance Confidential Report No. L5FO7a* (*Wartime Report No. L-635*), July, 1945. 65 pp., diagrs. 3 references.

Mean Specific Heats for Working Media of Gas Turbine Powerplants. Newman A. Hall. *SAE Quarterly Transactions*, Vol. 1, No. 3, July, 1947, pp. 490–497, figs. Discussion, p. 497. (*See* AER 3/47:58.)

Predicted Effects of the Atmosphere on Turbine-Type Aircraft Engines. A. Dolinsky and F. W. Disch. *SAE Quarterly Transactions*, Vol. 1, No. 3, July, 1947, pp. 519–528, diagrs. 5 references. (*See* AER 3/47:59.)

NACA Investigation of a Jet-Propulsion System Applicable to Flight. *U.S., N.A.C.A., Advance Confidential Report No. L4D26* (*Wartime Report No. L-528*), April, 1944. 51 pp., diagrs. 1 reference.

The British Outlook on Future Aviation Engines. F. R. Banks. *SAE Journal*, Vol. 55, No. 9, September, 1947, pp. 31, 32, 34.

An outline of the characteristics of gas-turbine engines and the practical difficulties they present in aircraft propulsion. Trends point to the eventual obsolescence of the piston engine and show the need for continued research and development.

The Ghost Lancastrian. *The Aeroplane*, Vol. 73, No. 1889, August 22, 1947, pp. 217–219, illus.

Details of the installation of two de Havilland Ghost gas turbines as the outboard engines of the four-engined Avro Lancastrian. The installation will be used to obtain flight-test data on fuel consumption and endurance.

Development of 109-007 Turbojet Engine. Leist. (August, 1943.) *U.S., Army Air Forces, Translation No. F-TS-2830-RE*, August, 1947. 3 pp., diagrs.

A report describing the advantages of a Daimler-Benz two-circuit turbojet engine under development. It is suggested that in order to improve the bearings and increase the critical r.p.m., the blades of the turbine and the compressor should be welded on a common thin wall drum-type rotor that is pinioned by two self-aligning bearings.

Description of BMW 003 Turbojet Engine. (*Bayerische Motorenwerke, BMW/003/U5*, April, 1944.) *U.S., Air Force, Translation No. F-TS-772-RE*, October, 1947. 39 pp., diagrs.

The Development of the Goblin Engine. E. S. Moult. *Royal Aeronautical Society, Journal*, Vol. 51, No. 440, August, 1947, pp. 655–678, illus. Discussion, pp. 678–685.

A history of the various stages in the development of the de Havilland Goblin II jet engine and its compressor. The design and metallurgical changes in the turbine and modifications made to the combustion chambers and the fuel and starting system are outlined. Special test methods are described.

Boeing's Propulsive Laboratory; How the New Research Laboratory Evaluates Gas Turbine Engines. *Western Flying*, Vol. 27, No. 10, October, 1947, pp. 20, 22, illus.

Engines, Ram-Jet

Ramjets for Fighters. E. Sänger and I. Bredt. (*Deutsche Forschungsanstalt für Segelflug, ZWB/UM/3509*, October, 1943.) *U.S. Army Air Forces, Translation No. F-TS-901-RE*, August, 1947. 67 pp., illus.

The characteristics of the ram-jet power plant are outlined and formulas are derived for its thrust, fuel consumption, and efficiency. The formulas are used to compute the theoretical characteristics of specific installations. Road and air towing tests confirmed the validity of the calculations. Flight-test data showed that the continuous compressorless jet propulsion of a Lorin tube, employing a cylindrical combustion chamber and high combustion temperatures, gave propulsion in the order of five-digit horsepower, when operating at speeds slightly below the velocity of sound. Efficiencies, however, would be about one-

third to one-half the total efficiency of conventional propeller driven power plants. An aircraft powered by a ram-jet engine should be suitable for low-level combat operation within a range of 100 km., for dive bombers with high approach altitude and a range of 500 km., and for fighters in the stratosphere with an action period of 1 hour.

Engines, Reciprocating

The Increase in Thrust Obtainable from a Power Plant Installation Using the Cooling-Air as a Propulsive Jet. A. B. P. Beeton. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2147*, May, 1945. 6 pp., diagrs. British Information Services, New York. $0.45.

The net thrust or drag of a power-plant cooling system has been estimated for various flight speeds. The effect of using the exhaust heat inside the duct is considered, and also the effect of burning additional fuel behind the engine. Typical figures are taken to produce a set of curves from which the respective merits of the various systems considered can be assessed. Useful gains in total thrust might be obtained at top speed by the use of internally discharging exhausts. The gain from auxiliary fuel burners behind the engine would only be considerable at extremely high speeds.

The Effect of Changing the Ratio of Exhaust-Valve Flow Capacity to Inlet-Valve Flow Capacity on Volumetric Efficiency and Output of a Single-Cylinder-Engine. James V. D. Eppes, James C. Livengood, and C. Fayette Taylor. *U.S., N.A.C.A., Technical Note No. 1365*, October, 1947. 38 pp., illus. 5 references.

Results of tests showed that best performance was obtained for about a unity ratio, corresponding to values approximately equal in diameter and lift. Conventional timing gave better performance than other timing arrangements tried.

Performance of a Double-Row Radial Aircraft Engine with Three Methods of Safety-Fuel Injection. Donald J. Michel, Robert O. Hickel, and Charles H. Voit. *U.S., N.A.C.A., Technical Note No. 1413*, August, 1947. 43 pp., illus. 6 references.

An investigation to determine whether a safety fuel with a flash point of 122°F. could be used successfully in a high-power radial aircraft engine without individual cylinder fuel-injection equipment. The fuel was injected into the combustion-air-stream by an N.A.C.A. injection impeller, an N.A.C.A. impinging-jet nozzle bar, and a standard nozzle bar. Throughout the range of engine powers, average fuel-air ratios, and combustion-air temperatures tested, the N.A.C.A. injection impeller produced the best mixture distribution. Between 1,200 and 1,600 b.hp., the required absolute manifold pressure and combustion-airflow was, for the three methods of injection tested, from 1.5 to 6.0 per cent greater than for the standard method of injecting gasoline. Idling characteristics of the engine with safety fuel were satisfactory, but it was impossible to start the engine either warm or cold by using a fuel with a flash point of 122°F. A warm engine could be started when a fuel with a flash point of 99°F. was used.

Fuel Injection Engine with Spark Ignition. Allan M. Starr. *SAE Journal*, Vol. 55, No. 9, September, 1947, pp. 28–30, diagrs. (Extended abstract of a paper: Fuel Injection with Spark Ignition.)

A description of design, operation and performance. Since the air intake is wide open at all loadings, fuel economy is obtained under partial loads. It is easier to start, has a wider range of speed, is lighter, more adaptable to small sizes, and less sensitive to different fuels than a Diesel engine with corresponding performance.

A Study of the Effect of Aftercooling on the Power and the Weight of a 2000-Horsepower Air-Cooled Engine Installation. George P. Wood and D. E. Brimley. *U.S., N.A.C.A., Memorandum Report (Wartime Report No. L-705)*, September, 1944. 27 pp., figs. 4 references.

Ground-Cooling and Flight Tests of an Airplane Equipped with a Nose-Blower Engine Cowling. David Biermann and L. I. Turner, Jr. *U.S., N.A.C.A., Advance Confidential Report (Wartime Report No. L-478)*, October, 1939. 28 pp., illus. 6 references.

Problems of Helicopter Powerplants. Robert Insley. *SAE Journal*, Vol. 55, No. 9, September, 1947, pp. 46–48, illus. (Extended abstract of a paper.) (Cf. AER 9/47:49.)

Developments in Diesel Engineering. Kalman J. De Juhasz and Gustavus A. Meyer. *U.S., Field Information Agency, Technical, Final Report No. 575*, May 20, 1947. 63 pp., illus. British Information Services, New York. $1.75.

The report emphasizes engine parts and assembly-group designs, materials, testing instruments, and research work that are considered to be new or little known in the United States, such as a Junkers fuel-injection test stand, a Junkers dynamometer, and a 48-cylinder aircraft engine. Sources of information in German wartime literature and unpublished manuscripts are commented on briefly.

Engines, Rocket

The Physics of Rockets. I–III. Howard S. Seifert, Mark M. Mills, and Martin Summerfield, *American Journal of Physics*, Vol. 15, Nos. 1, 2, 3, January-February, March-April, May-June, 1947, pp. 1–21; 121–140; 255–272; illus., diagrs. 8, 6, 16 references.

An extensive, mathematical exposition of propulsion by rockets that operate independently of the external atmosphere and do not use propulsive-duct devices. **I.** The formulas for the physical relations employed in rocket theory and the action within a nozzle during adiabatic flow are developed and used to express the characteristics of solid-propellant, restricted-burning, and unrestricted-burning rockets. **II.** An outline of properties of liquid propellants used in monopropellant and bipropellant rockets, general design characteristics of these types of rocket motor, typical motor calculations, internal heat transfer, and the behavior of rocket jets. Liquid-propellant rocket systems and their operation and applications are illustrated by current designs. **III.** The historical development of the theory of the long-range rocket is traced. The vertical motion of a rocket is analyzed to determine the parameters of a rocket having a maximum range. The best solution to the problems of energy and velocity in flight beyond the gravitational field of the earth may be found in the use of a multistage rocket. Nuclear energy is considered as a source of propulsive power, and the characteristics of such a hypothetical rocket are calculated. The changes in the behavior of the "classical" rocket brought about by application of the laws of relativity are illustrated.

Aircraft Rocket Motors. A. D. Baxter. *Aircraft Engineering*, Vol. 19, No. 222, August, 1947, pp. 249–257, illus.

A study of German developments in the application of hydrogen peroxide as rocket fuel. The design, operation, and performance of German jet engines and the components of their systems are detailed and illustrated.

Rocketry at Westcott: A Visit to the Ministry of Supply Rocket-Propulsion Establishment. *Flight*, Vol. 52, No. 2017, August 21, 1947, pp. 190, 205, illus.

Fire Prevention

An Electronic Fire Alarm. *The Aeroplane*, Vol. 73, No. 1889, August 22, 1947, pp. 228, 229, illus.

The Electricon System of Fire Prevention developed by Ronald Trist and Co., Ltd., of Slough, Bucks., England, is designed for installation in baggage compartments and cable conduits. The detector unit consists of a light source and a photoelectric cell that transmits a signal to a cold-cathode relay, which activates indicator and alarm circuits.

Flight Technique

Flight Refueling or Assisted Take-Off? H. R. Bunn. *Aeronautics*, Vol. 17, No. 2, September, 1947, pp. 40–43, diagrs.

The reduction of take-off and landing restrictions, the increased pay load, and the low cost of installation which flight refueling offers make it a commercially practical operational technique which can be substituted for assisted take-off.

All-Weather Flying Center Develops New Operational Aids; Progress Report on Air Force Group at Wilmington, Ohio. Robert Hotz. *Aviation Week*, Vol. 47, No. 17, October 27, 1947, pp. 11, 12, illus.

Ditching Tests with a $^1/_{10}$-Size Model of the Army A-20A Airplane in the Langley Tank No. 2 and on an Outdoor Catapult. George A. Jarvis and Margaret F. Steiner. *U.S., N.A.C.A.,*

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Memorandum Report L4K29a (*Wartime Report No. L-618*), November, 1944. 23 pp., illus. 3 references.

Ditching Tests with $^1/_{16}$-Size Models of the Army B-18 Airplane in Langley Tank No. 2 and on an Outdoor Catapult. Robert P. Tarshis and Thelma Stewart. *U.S., N.A.C.A., Memorandum Report No. L5C24* (*Wartime Report No. L-621*), April, 1945. 22 pp., illus. 2 references.

Ditching Tests with a $^1/_{16}$-Size Dynamic Model of the Army B-24 Airplane in Langley Tank No. 2 and on an Outdoor Catapult. Lloyd J. Fisher and Margaret F. Steiner. *U.S., N.A.C.A., Memorandum Report No. L5D07* (*Wartime Report No. L-620*), April, 1945. 45 pp., illus. 3 references.

Accelerations and Bottom Pressures Measured on a B-24D Airplane in a Ditching Test. Margaret F. Steiner. *U.S., N.A.C.A., Memorandum Report No. L4K14* (*Wartime Report No. L-648*), November, 1944. 29 pp., illus.

Ditching Tests with a $^1/_{12}$-Size Model of the Army B-26 Airplane in NACA Tank No. 2 and on an Outdoor Catapult. Lloyd J. Fisher and Margaret F. Steiner. *U.S., N.A.C.A., Memorandum Report* (*Wartime Report No. L-619*), August, 1944. 39 pp., illus.

Flight Testing and Performance

Ignoration of Distortional Co-Ordinates in the Theory of Stability and Control. W. J. Duncan. *College of Aeronautics, Cranfield, England, Report No. 1*, December, 1946. 5 pp. 3 references.

The method proposed by Gates and Lyon for the theoretical treatment of the stability and control of deformable aircraft ignores the distortion coordinate. The influence of structural distortion is allowed for by modification of the derivatives and other coefficients. In this report an exact method for eliminating the distortion coordinates is given. The conditions in which the true eliminant conforms with the simplification of Gates and Lyon are examined. In general, the simplification is not justified mathematically, but in certain circumstances it provides an acceptable approximation. The simplification will not be practically valid unless the distortions are quasistatic—that is, unless they occur so relatively slowly that the associated inertia forces are negligible.

A Continuation of Longitudinal Stability and Control Analysis. II—Interpretation of Flight Tests. S. B. Gates and H. M. Lyon. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2028*, August, 1944. 41 pp., figs. 5 references. British Information Services, New York. $2.25.

A technique and method of analysis of flight-test data which can be used either with trim curves plotted over the speed range or with stick-force data plotted over acceleration in pull-outs. A method of building up distorted trim and maneuver curves from the basic linear diagram is described and is illustrated for cases in which one of the tailplane or elevator derivatives such as the rate of change of tailplane lift with elevator angle tends to zero at a finite reversal speed. From a set of such diagrams it may be possible to diagnose the cause of handling troubles from limited information, when there is not time to complete and analyze a full set of flight tests.

Introduction to the Lecture on Natural and Artificial Longitudinal Stability. Ernst Heinkel. (*ZWB/DAL/1071-41.*) *Cornell Aeronautical Laboratory*, July, 1947. 2 pp.

The design of aircraft with increased engine performance and increased speed has resulted in a loss of inherent longitudinal stability. Design trends point to the necessity of compensating for this deficiency by automatic control.

Instrumentation for Flight Testing Airplanes. W. G. Brombacher. *Instruments*, Vol. 20, No. 8, August, 1947, pp. 700–708, tables. 31 references.

The difficulty of procuring specialized instruments to record flight-test data makes it necessary to adapt instruments originally developed for other purposes. The instrument elements that are now available or may be developed are tabulated. The phenomena to be measured, the appropriate types of installation, and the ranges of operation are shown. Stylus recorders are of limited application. Electrical remote indicators are more flexible and can provide better dynamic recording.

Wind-Tunnel Investigation of Effects of Unsymmetrical Horizontal-Tail Arrangements on Power-On Static Longitudinal Stability of a Single-Engine Airplane Model. Paul E. Purser and Margaret F. Spear. *U.S., N.A.C.A., Technical Note No. 1474*, October, 1947. 43 pp., illus. 9 references.

Although extreme asymmetry in the horizontal tail showed a reduction in power effects on longitudinal stability, the particular arrangement tested did not show marked improvement. Further research on slipstream behind various propeller-fuselage-wing combinations is indicated.

Correlation of Wind-Tunnel Predictions with Flight Tests of a Twin-Engine Patrol Airplane. II—Lateral- and Directional-Stability and -Control Characteristics. Noel K. Delany and William M. Kauffman. *U.S., N.A.C.A., Memorandum Report No. A5H30* (*Wartime Report No. A-71*), August, 1945. 48 pp., illus. 12 references.

The Effect of Altitude on Bomber Performance. Paul R. Hill and John L. Crigler. *U.S., N.A.C.A., Memorandum Report* (*Wartime Report No. L-546*), October, 1943. 46 pp., illus. 8 references.

Measurements of the Flying Qualities of a Hawker Hurricane Airplane. J. M. Nissen and W. H. Phillips. *U.S., N.A.C.A., Memorandum Report* (*Wartime Report No. L-565*), April, 1942. 47 pp., illus. 1 reference.

Flight Tests of Various Tail Modifications on the Brewster XSBA-1 Airplane. I—Measurements of Flying Qualities with Original Tail Surfaces. W. H. Phillips and J. M. Nissen. *U.S., N.A.C.A., Advance Restricted Report No. 3F07* (*Wartime Report No. L-412*), June, 1943. 56 pp., illus. 1 reference.

Effect of Propeller Operation on the Pitching Moments of Single-Engine Monoplanes. Harry J. Goett and H. R. Pass. *U.S., N.A.C.A., Advance Confidential Report* (*Wartime Report No. L-761*), May, 1941. 80 pp., diagrs. 19 references.

Tail-Load Measurements on the XB-15 Bomber in Gusty Air. H. A. Pearson and J. B. Garvin. *U.S., N.A.C.A., Memorandum Report* (*Wartime Report No. L-548*), April, 1941. 23 pp., illus. 3 references.

An Analysis of the Indications of the University of Chicago Airborne Turbulence Indicator in Gusty Air. H. B. Tolefson and K. G. Pratt. *U.S., N.A.C.A., Memorandum Report No. L6G08* (*Wartime Report No. L-723*), August, 1946. 16 pp., figs. 6 references.

XC-35 Gust Research Project: Operation in Cumulus Congestus Cloud on July 31, 1941; Maximum Gust Intensities. *U.S., N.A.C.A., Restricted Bulletin* (*Wartime Report No. L-555*), April, 1942. 6 pp., diagrs. 6 references.

Some Flight Measurements of Pressure Distribution During Tail Buffeting. John Boshar. *U.S., N.A.C.A., Memorandum Report No. L5J06* (*Wartime Report No. L-656*), October, 1945. 22 pp., illus. 4 references.

Estimates of the Vertical-Tail Loads of a Bell P-63A-1 Airplane (AAF No. 42-68889) in Accelerated Rolling Maneuvers Based on Flight Tests with Two Vertical-Tail Arrangements. Harold I. Johnson. *U.S., N.A.C.A., Memorandum Report No. L4K30a* (*Wartime Report No. L-600*), November, 1944. 16 pp., illus. 2 references.

Elevator Stick Forces in Spins as Computed from Wind-Tunnel Measurements. Oscar Seidman and J. W. Klinar. *U.S., N.A.C.A., Advance Restricted Report* (*Wartime Report No. L-422*), October, 1942. 24 pp., diagrs. 2 references.

Derivation of Charts for Determining the Horizontal Tail Load Variation with Any Elevator Motion. Henry A. Pearson. *U.S., N.A.C.A., Advance Restricted Report* (*Wartime Report No. L-488*), January, 1943. 31 pp., diagrs. 4 references.

Additional Power-On Wind Tunnel Tests of the $^1/_8$-Scale Model of the Brewster F2A Airplane with Full-Span Slotted Flaps. John G. Lowry. *U.S., N.A.C.A., Memorandum Report* (*Wartime Report No. L-708*), October, 1941. 13 pp., figs. 2 references.

Comparison of Free-Spinning Wind-Tunnel Results with Corresponding Full-Scale Spin Results. Oscar Seidman and A. I. Neihouse. *U.S., N.A.C.A., Memorandum Report* (*Wartime Report No. L-737*), December, 1938. 11 pp., table. 7 references.

Multiengine Airplane Spin Characteristics as Indicated by Model Tests in the Free-Spinning Wind Tunnel. Oscar Seidman and Robert W. Kamm. *U.S., N.A.C.A., Advance Restricted Reports* (*Wartime Report No. L-721*), July, 1942. 18 pp., illus. 8 references.

Fuels

Experimental Studies of the Knock-Limited Blending Characteristics of Aviation Fuels. III—Aromatics and Cycloparaffins. I. L. Drell and J. D. Wear. *U.S., N.A.C.A., Technical Note No. 1416*, August, 1947. 20 pp., figs. 3 references. (Cf. AER 11/47:36.)

An analysis of the knock-limited power at various blend compositions of several aromatics and cycloparaffins individually blended with paraffinic base stocks as determined in an air-cooled aircraft-engine cylinder at fuel-air ratios of 0.07 and 0.10. The extended reciprocal blending relation suggested in *N.A.C.A. Report No. 760, 1943*, is not generally applicable to such non-paraffinic components, but might possibly be useful as an approximation over a limited range of composition for aromatic blends.

Danger of Explosion of Fuel Tanks Under Surface and Altitude Conditions; Proposal for a Safety Measure. M. Sack. (*ZWB/FB/432*, August 2, 1935.) *Cornell Aeronautical Laboratory*, May, 1947. 9 pp., figs.

Mixing compositions are calculated for the fuel-air mixtures of three common fuels and of hexane. The range of inflammability is given as a function of pressure and temperature under certain assumptions. The graphs show whether an inflammable mixture can be present under certain given conditions that would make special safety measures necessary. Exhaust gases can be introduced into the empty space of the tanks as a safety measure.

Firing of Incendiary Bullets at Fuel. Langhammer. (*Messerschmitt Technischer Bericht 27/40*, November 25, 1940.) *Cornell Aeronautical Laboratory*, May, 1947. 21 pp., figs.

Firing-range tests were made to determine the inflammability of fuels when fired on with incendiary bullets and high-explosive shells. Benzol fuels in solid or liquid form were noninflammable and fuel oils needed no special protection. Ignition of aviation gasoline when hit by incendiary bullets could not be prevented either by cooling to low temperatures or with the aid of carbon-dioxide addition and pressure, or both.

Guided Missiles

Heat Insulation of Outer Casing of a Missile to Avoid Decomposition of the Explosive Charge. (*Hannover, Technische Hochschule, ZWB/TH Hann/47/16*, December, 1941.) *U.S., Army Air Forces, Translation No. F-TS-3110-RE*, August, 1947. 5 pp., figs.

Asbestos cemented to steel with waterglass and asbestos cemented with powdered kieselgur and binder were tested as insulating agents. When the steel was heated to 300°C., the exposed surface of the kieselgur remained below 180°C. and the exposed surface of the asbestos insulation remained below 100°C.

A Multi-Channel Oscillograph Utilizing Color Film. W. J. Leiss, F. R. Nitchie, and B. B. Underhill. *Instruments*, Vol. 20, No. 8, August, 1947, pp. 709–711, illus.

The indication of a six-element galvanometer oscillograph is recorded on color film. Light beams of six different colors produce the traces. Four represent the input of four linear amplifiers and two record the differences between two pairs of input signals. The use of different colors makes it possible to interpret and resolve the record rapidly in spite of the complex interwinding of the traces. The instrument was developed for guided missiles.

'Chutes Save Rocket Secrets. Stephen L. Freeland. *Popular Science Monthly*, Vol. 151, No. 3, September, 1947, pp. 124–128, illus., diagrs.

A description of the release mechanism and ribbon parachute used to recover the high-altitude instrumentation unit ejected from a V-2 missile at an altitude of 68 miles in the Blossom I project at White Sands Proving Grounds in February, 1947. Photographs and diagrams are given of the unit, its instruments, and the release device.

Heat Exchangers

Regenerative Type Heat Exchanger A.V.A. Göttingen. D. G. Shepherd. *Gt. Brit., British Intelligence Objectives Sub-Committee, Final Report No. 298, Item Nos. 5, 26.* 10 pp., diagrs. British Information Services, New York. $0.35.

Experimental work by Dr. Ritz on heat-transfer coefficients at Reynolds Numbers between 50 and 200 has shown that the Nusselt Number is independent of the Reynolds Number. A regenerative heat exchanger based on the resulting theory of heat transmission at low Reynolds Numbers has been developed. It weighs 0.25 to 0.35 lb. per hp. and obtains an effectiveness of from 90 to 95 per cent.

Generalized Equations for Selection Charts for Heat Exchangers in Aircraft. Arthur N. Tifford and George P. Wood. *U.S., N.A.C.A., Advance Confidential Report (Wartime Report No. L-427)*, April, 1942. 15 pp., figs. 11 references.

Design, Selection, and Installation of Aircraft Heat Exchangers. George P. Wood and Maurice J. Brevoort. *U.S., N.A.C.A., Advance Restricted Report No. 3G31 (Wartime Report No. L-341)*, July, 1943. 146 pp., diagrs. 31 references.

Use of Stagnation in Calculating Rate of Heat Transfer in Aircraft Heat Exchangers. George P. Wood. *U.S., N.A.C.A., Restricted Bulletin No. 3J30 (Wartime Report No. L-298)*, October, 1943. 13 pp., figs. 11 references.

An Investigation of Aircraft Heaters. III—Measured and Predicted Performance of Double Tube Heat Exchangers. R. C. Martinelli, E. B. Weinberg, E. H. Morrin, and L. M. K. Boelter. *U.S., N.A.C.A., Advance Restricted Report (Wartime Report No. W-98)*, October, 1942. 45 pp., diagrs.

A Comparison of Analytically and Experimentally Determined Isothermal Pressure Losses in a Heat-Exchanger Installation. Wesley H. Hillendahl. *U.S., N.A.C.A., Advance Restricted Report No. 5C19 (Wartime Report No. A-26)*, May, 1945. 36 pp., illus. 5 references.

Flight Tests of Several Exhaust-Gas-to-Air Heat Exchangers in a B-17F Airplane. Bonne C. Look and James Selna. *U.S., N.A.C.A., Memorandum Report (Wartime Report No. A-29)*, April, 1944. 99 pp., illus. 3 references.

Ice Prevention

Icing Properties of Noncyclonic Winter Stratus Clouds. William Lewis. *U.S., N.A.C.A., Technical Note No. 1391*, September, 1947. 12 pp., figs. 2 references.

In noncyclonic winter stratus clouds, if snow is not falling, the liquid water concentration can be determined approximately from the temperature of the base and the thickness of the layer. A most-adiabatic lapse rate and constant total water content within the cloud is assumed. Snowfall progressively depletes the liquid water. The process starts at the cloud base and continues until only a thin layer of liquid water remains in the top of the cloud.

A Further Investigation of the Meteorological Conditions Conducive to Aircraft Icing. William Lewis, Dwight B. Kline, and Charles P. Steinmetz. *U.S., N.A.C.A., Technical Note No. 1424*, October, 1947. 26 pp., illus. 4 references.

Data from flight observations in icing conditions on liquid water content, temperature, and mean-effective drop diameter are shown to be consistent with previously proposed values. Data on drop-size distribution with the rotating-cylinder method, although consistent with previous data, were inconsistent with data derived from stationary cylinder investigations. The relation between temperature and maximum water content in layer clouds is discussed, and estimates are given for the highest values of water to be expected in layer clouds at various temperatures.

Laboratory Investigation of Ice Formation and Elimination in the Induction System of a Large Twin-Engine Cargo Aircraft. Willard D. Coles. *U.S., N.A.C.A., Technical Note No. 1427*, September, 1947. 27 pp., illus. 7 references.

A three-barrel injection-type carburetor and a supercharger housing with spinner-type fuel injection were examined. Experiments determined the basic icing characteristics of this system and its hot-air deicing performance. The time required to restore 95 per cent of the maximum hot-air flow at a given wet-bulb inlet-air temperature increased as the ice formations became larger and the icing temperatures decreased. Impact-ice formations on the entrance screen and the top of the carburetor reduced the overall fuel-air ratio and increased the spread between the overall ratio and the fuel-air ratio of the individual cylinders.

An Investigation of a Thermal Ice-Prevention System for a C-46 Cargo Airplane. U. S. N.A.C.A.

I—Analysis of the Thermal Design for Wings, Empennage, and Windshield. Carr B. Neel, Jr. *Advance Restricted Report No. 5A03 (Wartime Report No. A-52)*, February, 1945. 81 pp., illus. 11 references.

III—Description of Thermal Ice-Prevention Equipment for Wings, Empennage, and Windshield. Alun R. Jones and Ray J. Spies, Jr. *Advance Restricted Report No. 5A03b* (*Wartime Report No. A-16*), February, 1945. 66 pp., illus. 6 references.

IV—Results of Flight Tests in Dry-Air and Natural-Icing Conditions. James Selna, Carr B. Neel, Jr., and E. Lewis Zeiller. *Advance Restricted Report No. 5A03c* (*Wartime Report No. A-22*), February, 1945. 113 pp., diagrs. 7 references.

V—Effect of Thermal System on Airplane Cruise Performance. James Selna. *Advance Restricted Report No. 5D06* (*Wartime Report No. A-9*), May, 1945. 20 pp., illus. 7 references.

VII—Effect of the Thermal System on the Wing-Structure Stresses as Established in Flight. Alun R. Jones and Bernard A. Schlaff. *Advance Restricted Report 5G20* (*Wartime Report No. A-48*), September, 1945. 42 pp., illus. 14 references.

Flight Test Report of Anti-Icing Installation on Me 210 Fighter Bomber. (*Messerschmitt 210/24*, February, 1942.) *U.S., Air Force, Translation No. F-TS-2069-RE*, October, 1947. 34 pp., illus. Electrical anti-icing was satisfactory down to —13°C. Rearrangement of anti-icing boots and heat surfaces is recommended for increased specific heat output.

Report on Icing Tests of Intake Ducts. (*Göttingen, Aerodynamische Versuchsanstalt*, January 7, 1940.) *U.S., Army Air Forces, Translation No. F-TS-2641-RE*, September, 1947. 24 pp., illus. Methods and evaluation of cold-chamber tests of protective screens for air-intake ducts. Changes in mesh size improved anti-icing characteristics.

Instruments, Engine

Engine Analyzer; Models D-2 and D-4 for Multi-Engined Aircraft. *Sperry Gyroscope Co., Inc., Publication No. 15-45A, and Supplement*, July, 1947. 9 pp., illus.

A bulletin giving specifications and describing the components and operation of two models, one for twin-engined and the other for four-engined aircraft. The analyzer indicates both the condition of individual spark plugs throughout the engines and also the mechanical operations in each cylinder. Either indication is produced on a single cathode-ray tube by operation of a condition-selector switch. Another switch, the cylinder selector, chooses the individual cylinder or spark plug and portion of the complete engine cycle to be observed. Ignition patterns and vibration patterns characteristic of the combustion conditions are reproduced.

Engine Analyzer Pinpoints Flight Trouble. *Aviation Week*, Vol. 47, No. 16, October 20, 1947, pp. 21, 22, illus. (Cf. preceding abstract.)

Aircraft Detonation Indicators. J. S. Bogen and W. J. Faust. *SAE Quarterly Transactions*, Vol. 1, No. 3, July, 1947, pp. 457–469, illus. (*See* AER 5/47:45.)

Instruments, Flight

Choosing Proper Light Plane Instruments. Gilbert C. Close. *Western Flying*, Vol. 27, No. 9, September, 1947, pp. 10, 11, illus.

Inaccuracy of instruments or their lack is one of the greatest causes of owner dissatisfaction. Factory versus owner installation of advance instrumentation is discussed. The instrumentation used should be adapted to the intended use of the airplane, such as for utility or pleasure flying.

High Speed Aircraft Flying Limitations and Handling Problems. F. W. Morgan. *Royal Aeronautical Society, Journal*, Vol. 51, No. 441, September, 1947, pp. 733–738.

As the critical Mach Number is approached, changes in trim take place which are finally superceded by the trim changes caused entirely by compressibility effects. Since the speed of sound decreases as the air temperature falls, the maximum permissible air speeds decrease with altitude. The high normal accelerations that may be introduced by maneuvers at high Mach Numbers require a flight instrument that will indicate the maximum permissible g on a sliding scale with the Mach Number. This Mach Number-g meter may also serve to indicate the approach of the transonic range and warn the pilot if any appreciable g were applied.

Flight Tests of the United Air Lines Stall Warning System C. J. Janes. *U.S., Civil Aeronautics Administration, Technical Development Report No. 50*, April, 1945. 15 pp., illus.

The transmitting elements of the system are located at the trailing edge of the wing and are activated by a decrease in pressure on the upper surface of the wing. Each element, which contains a diaphragm switch, is connected to a warning light on the pilot's instrument board. The margin between the speed at which warning is given and the stalling speed is adequate under nonicing conditions. When simulated ice is applied to the leading edge of the wing, there is a great difference in the stalling speed but little change in the speed at which warning is given.

Development of a Flight Level Indicator. Robert W. Knight and George L. Pigman. *U.S., Civil Aeronautics Administration, Technical Development Report No. 46*, January, 1945. 10 pp., illus.

The development of an instrument designed to provide vertical separation between aircraft in flight by relating flight altitude levels to compass directions. The instrument consists essentially of an aneroid barometer mechanism providing a uniform measurement of pressure altitude from a fixed standard reference pressure. The dial of the instrument is graduated like a compass rose, so that a definite pressure altitude of operation corresponds to each heading of the airplane. The use of this instrument is suggested as a possible solution to the problem of assigning safe cruising altitudes for aircraft flying along, across, or off the civil airways. Flight testing and use of the instrument over a considerable period of time indicated the practicability of the proposed method of flight control.

Instruments, Meteorological

New Wind-Speed and Direction Indicator for Aircraft Tests. *U.S., National Bureau of Standards, Technical News Bulletin*, Vol. 31, No. 9, September, 1947, pp. 97–99, illus.

A portable wind vane and anemometer for aircraft take-off tests. Wind velocity is measured by a magnetic tachometer coupled to the rotating propeller shaft. Wind direction is indicated simultaneously on a circular scale. Adjustment may be made for wind speeds as low as $^1/_2$ knot. Automatic temperature compensation permits the device to be used in all weather conditions.

Insurance, Safety, and Rescue

Life Rafts. I. J. Hammill. *Air Transport*, Vol. 5, No. 9, September, 1947, pp. 40, 41, illus.

Landing Gear

The Explicit Determination of Orifice Parameters on Shock Absorbers. G. A. Dirac. *Aircraft Engineering*, Vol. 19, No. 222, August, 1947, pp. 258–262, fig.

Methods by which the orifice parameter can be determined in less time than that required for the prediction of the solution with a chosen parameter. Reaction-time relations, travel-time relations, or velocity-time relations may be used, in accordance with the data available. The methods may be used to design both simple and complicated shock-absorber systems.

Lighter-Than-Air

Cargo Ships of the Air. John H. Frederick. *Distribution Age*, Vol. 46, No. 8, August, 1947, pp. 33, 34, 76, illus.

The large volume of cargo which lighter-than-air craft are able to accommodate indicates that they might be employed profitably in long-distance scheduled operations. The low cruising speed of the airship limits its ton-mileage, but statistics compiled by the Goodyear Aircraft Corp. show that it might be possible to operate in the 2,500-mile range at rates as low as 7.7 cents per ton-mile and in the 3,500-mile range at 20 cents per ton-mile.

Lubrication and Lubricants

A Study of Metal Transfer Between Sliding Surfaces. B. W. Sakmann, N. Grossman, and John W. Irvine, Jr. *U. S., N.A.-*

B. F. Goodrich tires outwear concrete in landing tests

RUBBER HITS CONCRETE with terrific impact when Lockheed's new drop-test machine goes into action. This mechanism tests landing gear by duplicating an actual landing.

The landing gears are lifted to the desired height on the 40-foot tower and the wheels are spun until they reach a speed of nearly 100 miles an hour. Then the landing gear drops to the concrete platform, simulating an airplane's 100 mile an hour touch-down on an airport runway. And for a few seconds, smoke pours from the tires as the wheels skid to a stop.

These punishing 125,000 pound blows are a severe test of the B. F. Goodrich tires used on the landing gear. Here's how they stood up: following the first eighty tests, Lockheed engineers reported that although a hole was worn in the concrete "runway" on which the tires landed, the tires themselves showed no appreciable wear!

These are standard B. F. Goodrich 17.00 x 20 Type III tires. The Type III tire was developed by B. F. Goodrich engineers to make landings smoother and cheaper. Its larger air volume and lower inflation pressure provide superior cushioning, wear resistance and safety.

And by using dual B. F. Goodrich tires, loads are distributed, tires last longer, safety and economy are increased. B. F. Goodrich engineers have advocated the use of multiple tires for fifteen years. And the first duals used were B. F. Goodrich tires.

Developing tires to meet the needs of today's and tomorrow's planes is a constant project of B. F. Goodrich engineers. *The B. F. Goodrich Company, Aeronautical Division, Akron, Ohio.*

B.F.Goodrich
FIRST IN RUBBER

C.A., Technical Note No. 1355, September, 1947. 14 pp., illus. 4 references.

The radioactive method was successfully applied to the measurement of metal transfer when both surfaces were of hardened steel. The uncertainty in the amount of transfer which exists when one of the surfaces was made radioactive by direct exposure to a cyclotron beam was reduced by adding the radioactive material as an alloying agent to a melt of the steel. In this way the distribution of activity throughout the surface was made more uniform. Insofar as it was possible to dissociate the effects of relative hardness and of the material itself, it appeared that, in the non-nitrided Nitralloy and nitrided Nitralloy combination, much more material was transferred from the softer to the harder material. In the comparison between chromium plate and nitrided Nitralloy, when both are harder than the non-nitrided rider, less material was transferred to the material of greater chemical difference, the chromium.

A Study of Piston-Ring Friction. James C. Livengood and Chapin Wallour. *U. S., N.A.C.A., Technical Note No. 1249*, August, 1947. 47 pp., illus. 4 references.

A porous chromium-plated cylinder caused slightly greater ring friction than a smooth steel cylinder. A porous chromium-plated top piston ring likewise increased the friction, but to a smaller degree. Piston-ring friction increased with increased engine speed and manifold pressure. It decreased, however, with increased cylinder-jacket temperature.

Maintenance

NATS Calls It "Progressive Maintenance." George Herrick. *Air Transport*, Vol. 5, No. 9, September, 1947. pp. 43, 44, 47, illus. A detailed description of the preventive maintenance schedule of the Naval Air Transport Service and a comparison with commercial practice.

Materials—General

Sperry Reflectogage. *Sperry Products, Inc., Sales Data Sheet No. 3700*, August 15, 1947. 6 pp., illus.

A quartz crystal and suitable electronic circuits are used to set up supersonic vibrations in the specimen to be measured. The resonant frequency of the material is observed on an oscilloscope, and from this information the thickness of the material is computed. The search element is applied only to one surface of the specimen. The indicator can be read directly for thicknesses up to 0.25 in. and indirectly for thicknesses up to 4.00 in. Metals, glass, unfilled plastics, and some rubbers can be tested. Tests can be made for lack of bond and internal flaws in special cases.

Fabric Facts for Operators; How to Identify the Different Grades of Airplane Fabrics, with Inspection and Testing Facts for Operators. William H. Weber. *Aviation Maintenance and Operations*, Vol. 8, No. 5, October, 1947, pp. 30, 31, illus.

Materials—Metals and Alloys

High Temperature Disc Forging Developments for Aircraft Gas Turbines. L. B. Fonda. *Steel Processing*, Vol. 33, No. 8, August, 1947, pp. 469–473, 486, 491, 500–502, illus.

An account of an investigation undertaken by the General Electric Company to determine the cause of failure of the Type I-40 turbine wheels, components of the jet engines powering the P-80. Specimens that represented various methods of handling, forging practices, heat-treatments, and materials from various sources were inspected and a total of 185 were tested to destruction. Ductility of the alloy was found to be the most important factor affecting their characteristics and one that could be improved by proper control of grain flow. The cause of failure was found to be unsound forgings, which can be avoided by the exercise of extreme care in the production of billets and ingots.

The Effect of Heat Treatment on the Bauschinger Effect in Duralumin. C. Gurney and Z. Borysowski. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2156*, March, 1945. 5 pp., figs. 2 references. British Information Services, New York. $0.45.

Duralumin that had been prestretched in the fully aged condition was heat-treated at temperatures between 80° and 180°C. for 2 to 24 hours. Without heat-treatment after stretching, compression proof stresses are less than those in tension (Bauschinger effect). The heat-treatments tried were all found beneficial, and after the best (16 hours at 120°C.), the compression proof stresses were nearly equal to the corresponding tensile values. The latter are not affected by this heat-treatment. Strut tests on materials with differently shaped stress-strain curves are needed to enable the practical value of the treatment to be assessed.

Babbitt Alloys for Plain Bearings. II. P. G. Forrester. *Engineering*, Vol. 164, No. 4257, pp. 208, 209, figs. (Cf. preceding abstract.)

A summary of the characteristics of Babbitt alloys, their composition, and metallurgy. Bearing design that provides good hydrodynamic characteristics specifies sufficient backing metal. Adequate bonding of the Babbitt liner will minimize the bearing failure characteristic of this metal.

Derivation of Stress, Strain, Temperature, Strain-Rate Relation for Plastic Deformation. J. D. Lubahn. *Journal of Applied Mechanics*, Vol 14, No. 3, September, 1947, pp. A-229–A-230.

Wrought Light Alloy Plants in Southern Germany. J. Harper, E. L. Ashley, and others. *Gt. Brit., British Intelligence Objectives Sub-Committee, Final Report No. 229, Item No. 21.* 71 pp., illus. British Information Services, New York. $1.90. A report on the continuous and semicontinuous casting processes used at the plants of Karl Schmidt G.m.b.H., Wieland-Werke A.G., Aluminium-Walzwerke Singen G.m.b.H., and Vereinigte Deutsche Metallwerke-Halbzeugwerke G.m.b.H.

Methods Used in the Preparation of Test Specimens. II. G. L. Smith. *Sheet Metal Industries*, Vol. 24, No. 245, September, 1947, pp. 1809–1814, 1824, illus. 5 references.

A description of various methods of identification marking and their effect on the specimen, and a survey of the techniques that can be used in sectioning and finishing a specimen and in drilling and cutting for chemical analysis.

Materials—Plastics and Plywood

The Buckling of Plywood Plates in Shear. R. C. T. Smith. *Australia, Council for Aeronautics, Report No. ACA-17*, October, 1946. 24 pp., figs. 9 references.

The Rayleigh-Ritz energy method is used to obtain approximate solutions for the buckling of rectangular plates and infinite strips of orthotropic material under uniform shear. The results obtained for finite plates with clamped edges are compared with those that Iguchi obtained using a series method, and the results obtained for infinite orthotropic strips are compared with the solution of the special case of an isotropic material solved by Southwell's exact method, to demonstrate the superiority of the Rayleigh-Ritz method. An example is worked out for a 0–90° plywood plate.

Molded Plastic Structures. James Lampman and Thomas E. Piper. *Western Flying*, Vol. 27, No. 10, October, 1947, pp. 18, 19, illus.

Glass fabrics bonded under low pressure with thermosetting resins are being used by Northrop Aircraft, Inc. The use of this high-strength fibrous material permits the consolidation of aircraft components into integral structures that have the desired rigidity or flexibility and adequate strength.

Experiences of an Aircraft Manufacturer with Sandwich Material. H. B. Gibbons. *SAE Quarterly Transactions*, Vol. 1, No. 3, July, 1947, pp. 415–428, illus. (*See* AER 3/47:73.)

Sandwich Materials: Metal Faces Stabilized by Honeycomb Cores. W. W. Troxell and H. C. Engel. *SAE Quarterly Transactions*, Vol. 1, No. 3, July, 1947, pp. 429–440, illus. (*See* AER 3/47:71.)

Philosophy for Design of Sandwich-Type Structure. John S. Korsberg. *SAE Quarterly Transactions*, Vol. 1, No. 3, July, 1947, pp. 408–414, illus. (*See* AER 3/47:73.)

Technical Butadiene Catalysts. von Susich. (*I. G. Farbenindustrie, IGF/Lae/Sus/25*, April, 1942.) *U.S., Army Air Forces, Translation No. F-TS-2607-RE*, July, 1947. 13 pp., illus.

An investigation of the physical and chemical properties of the catalyst used in the production of butadiene from 1.3 and 1.4 butanediols. The active constituent was found to be free phosphoric acid, the quantity of which depended on the conditions under which the catalyst was prepared. The potency of a given specimen could be determined by chemical and x-ray analysis. All attempts to lengthen the life of the catalyst, which was limited by resinification, failed.

Materials—Protective Coating

The Prevention of Metallic Corrosion. G. Fitzgerald-Lee. *The Aeroplane*, Vol. 73, No. 1890, August 29, 1947, pp. 251–253, illus.

An analysis of the causes that underly the corrosion of materials which shows that the main factors affecting the corrosion of a metal are its composition and its physical condition. Methods of corrosion prevention may be classified as physical, chemical, and electrolytic. In the first method, the grain structure of the metal is altered or coating of a foreign material is employed. The other two methods deposit, thicken, or intensify an oxide or salt film on the surface. Thirty of the more common commercial methods of corrosion prevention are briefly described.

Electrolytic Oxidation of Aluminum-Magnesium-Zinc Alloy HY-43. O. Lohrmann. (*Deutsche Versuchsanstalt für Luftfahrt, ZWB/UM/1030*, June, 1943.) *U.S., Army Air Forces, Translation No. F-TS-1858-RE*, August, 1947. 19 pp., illus.

Test report on the effect of operating conditions during anodizing on the corrosion-resisting properties of the oxide coating. Optimum results were obtained with an electrolyte temperature of 20°C., a voltage of 13 volts, and a processing time of between 15 and 40 min.

The Corrosion of Metals. VIII—Aluminum and Its Alloys. *Sheet Metal Industries*, Vol. 24, No. 244, August, 1947, pp. 1633–1636, fig. 11 references.

Meteorology

Gusts. W. Tye. *Royal Aeronautical Society, Journal*, Vol. 51, No. 441, September, 1947, pp. 721–732, figs.

A summary of present knowledge of gusts. The simplified concept of the sharp-edged gust is amplified to describe the actual meteorological phenomenon and to show its effect on aircraft structures and controllability. Gaps that exist in present knowledge must be filled before the present arbitrary airworthiness requirements can be replaced by real ones.

Experimental Investigation to Determine the Relative Magnitude of Vertical and Horizontal Gusts in the Atmosphere. Philip Donely. *U.S., N.A.C.A., Memorandum Report (Wartime Report No. L-576)*, July, 1940. 13 pp., figs. 2 references.

Hail Formation, Vertical Current, and Icing of Aircraft. E. Gaviola and F. Alsina Fuertes. *Journal of Meteorology*, Vol. 4, No. 4, August, 1947, pp. 116–120. 11 references.

Aeronautical experience shows that it is not necessary to assume strong ascending currents in clouds or tornadic action for the formation of large hailstones. A tentative description of the formation assumes that a transparent ice surface forms on the wet surface of subcooled water droplets and ice or snow crystals. When the surface dries, an opaque, white layer forms. In an atmosphere at rest with an absolute humidity of 10 $Gm.^{-3}$, a stone could grow to a diameter of 5 cm. while falling from 8 to 4 km. Icing on aircraft appears to follow the same pattern.

Concerning the Velocity of Evaporation of Small Droplets in a Gas Atmosphere. N. Fuchs. (*Zhurnal Fiziki S.S.S.R.* (Moscow), Vol. 6, 1934, pp. 224–243.) *U.S., N.A.C.A., Technical Memorandum No. 1160*, August, 1947. 20 pp. 15 references.

The basic simplifying assumptions made in Maxwell's equation for the rate of evaporation of small droplets are analyzed. For the small sizes and small weight concentrations present in normal fog, the evaporation factor can be regarded as quasistationary in most cases, and the errors introduced by the basic assumptions can be corrected by simple calculations.

The Separation of Analysis and Forecasting: A New Basis for Weather Service Operations. B. G. Holzman. *American Meteorological Society, Bulletin*, Vol. 28, No. 6, June, 1947, pp. 281–293, figs.

On the General Circulation of the Atmosphere in Middle Latitudes. *American Meteorological Society, Bulletin*, Vol. 28, No. 6, June, 1947, pp. 255–279, figs. 20 references. Report on synoptic, theoretical, and experimental studies conducted at the University of Chicago during the 1946–1947 academic year.

Physical Nature of Some Fluctuations in the Speed of the Zonal Circulation. Jerome Namias. *Journal of Meteorology*, Vol. 4, No. 4, August, 1947, pp. 125–133, figs. 10 references.

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% Aeronautical Engineering Review

The Automatic Weather Station. Charels R. Coates. *United States Naval Institute, Proceedings*, Vol. 73, No. 535, September, 1947, pp. 1097–1102, illus.

The Navy TDM Automatic Weather Station, developed by the Friez Instrument Division of the Bendix Aviation Corporation, is a complete unattended weather observatory. It transmits by radio according to a preset 24-hour schedule all conventional meteorological data except visibility and cloud coverage. The installation can operate at 15-min. intervals unattended for a period of 2 months.

Military Aviation

Survey of Proximity Fuze Development. Chester H. Page and Allen V. Astin. *American Journal of Physics*, Vol 15, No. 2, March-April, 1947, pp. 95–118, illus.

Naval Aviation

The Role of the Patrol Bombers. William H. Morris. *United States Naval Institute, Proceedings*, Vol. 73, No. 535, September, 1947, pp. 1049–1059, illus. An appraisal of the effectiveness of Naval patrol bombers in long-range search, patrol, and armed reconnaissance operations in the pacific in World War II.

Naval Aviation; A Photographic Summary of Deck Landing Trials Held in H. M. S. Illustrious. *Aeronautics*, Vol. 17, No. 2, September, 1947, pp. 45–53, illus.

Navigation

Spherical Navigation. Carl J. Crane. *Air Force*, Vol. 30, No. 9, September, 1947, pp. 32, 33, illus.

Navigation charts with a spherical contour proportional to that of the earth's surface make it possible for the navigator to dispense with the corrections required when plane projections are used. The earth or the celestial sphere can be represented on curved plastic sectors and a large-scale sphere or hemisphere key can be used to select the charts required for a particular route.

Photography

The Optical System of the NACA 400,000-Frame-per-Second Motion-Picture Camera. Cearcy D. Miller. *U.S., N.A.C.A., Technical Note No. 1405*, August, 1947. 31 pp., illus. 5 references.

An ultra-high-speed camera developed to investigate knock characteristics is being operated at the rate of 400,000 frames per sec. and is expected to attain speeds of 1,000,000 frames per sec. The primary image is focused on one of a set of condensing mirrors mounted around a rotating spindle. During the rotation one mirror after the other reflects the primary image to a succession of lenses which refocus the reflection on a photographic strip. Variation in curvature of the rotating mirrors and the use of four primary images that are simultaneously reflected permit the exposure of 204 images during one revolution of the rotor. The increased speed warrants the sacrifice in definition and optical speed inherent in the system.

High-Speed Photography. II—Radiography and Motion Pictures. G. A. Hawkins and C. E. Balleissen. *Machine Design*, Vol. 19, No. 9, September, 1947, pp. 121–126, illus. 14 references. (Cf. AER 11/47:43.)

A description of the high-speed X-ray tube that makes it possible to record the performance of mechanical parts such as turbine rotors, located within housings. The Western Electric Fastex and the Bell Telephone Laboratories ribbon frame camera are two high-speed motion-picture cameras that have been developed to record not only the action of moving parts but also the indication of strain gages and accelerometers.

Photographing Things to Come. M. W. Warren. *Society of Motion Picture Engineers, Journal*, Vol. 49, No. 1, July, 1947, pp. 82–88.

A summary of future U.S.A.F. requirements for motion picture equipment that may be operated at altitudes of 100,000 ft. and speeds of 1,500 m.p.h. Three wartime cameras, the 0-5A radar recording camera, the A-6 motion-picture camera, and the Sonne S-7 continuous-strip camera are briefly described.

A Stabilization System by Rate Measurement. Avery Bockner. *Society of Motion Picture Engineers, Journal*, Vol. 49, No. 1, July, 1947, pp. 88–92. The application of a wartime system of airplane gun-turret stabilization to the stabilization of aerial cameras.

Space Resection. Everett L. Merritt. *Photogrammetric Engineering*, Vol. 13, No. 3, September, 1947, pp. 415–441, diagrs.

A New Era in Surveying and Mapping Curricula. George H. Harding. *Photogrammetric Engineering*, Vol. 13, No. 3, September, 1947, pp. 395–401.

Symposium of Ideas Relative to Education in Photogrammetry. A. O. Quinn and G. C. Mares. *Photogrammetric Engineering*, Vol. 13, No. 3, September, 1947, pp. 330–394.

Tilt Analysis Based on Vertical Control Data. Earl Church. *Photogrammetric Engineering*, Vol. 13, No. 3, September, 1947, pp. 463–473.

Methods of Supplementing Geodetic Control. Duane Lyon. *Photogrammetric Engineering*, Vol. 13, No. 3, September, 1947, pp. 481–513, illus.

A Corrected Master Parallax Table. B. B. Lane, Jr., and G. T. McNeil. *Photogrammetric Engineering*, Vol. 13, No. 3, September, 1947, pp. 453–462, tables.

Some Developments in the Use of Air Photographs for Forest Surveys. H. E. Seely. *Photogrammetric Engineering*, Vol. 13, No. 3, September, 1947, pp. 443–452.

Tilt by the Graphical Pyramid Method. G. T. McNeil. *Photogrammetric Engineering*, Vol. 13, No. 3, September, 1947, pp. 403–414, diagrs. Discussion, p. 414.

Production—General

Airframe Production; A Review of Wartime Manufacture by the British Aircraft Industry. I—Expansion and General Organization: Pre-Production, Tooling and Supply. Eric Mensforth. *Aircraft Production*, Vol. 9, No. 107, September, 1947, pp. 343–350, figs. 4 references. (*See* AER 9/47:59.)

Seeing-Conditions in Industry; Improved Lighting and Light Colours as a Stimulus to Production. C. T. McMillan. *Aircraft Production*, Vol. 9, No. 107, September, 1947, pp. 323–326, illus.

Production Methods

The Spot Welding of Dissimilar Aluminum Alloys in the 0.040-Inch Thickness. W. F. Hess, R. A. Wyant, and F. J. Winsor. *U.S., N.A.C.A., Technical Note No. 1322*, October, 1947. 35 pp., illus. 6 references.

Covers an investigation of the spot welding of dissimilar alloy combinations of the following alloys in the 0.040-in. thickness: Alclad 24S-T, bare 24S-T, 52S-1/2H, 3S-1/2H, 61S-T, R-301-T, Alclad 75S-T, and bare 75S-T. Results indicate that chemical treatment of dissimilar alloys prior to spot welding is a less difficult problem than the treatment of some similar alloy combinations and that the combinations investigated can be spot-welded with little difficulty. The maximum average shear strength of sound welds and the current range over which sound welds may be produced are usually intermediate between the corresponding values for each of the component alloys welded individually.

The Welding of Aluminum-Magnesium Alloys. E. A. G. Liddiard. *Sheet Metal Industries*, Vol. 24, No. 245, September, 1947, pp. 1857–1860, 1862, illus. 14 references.

A symposium on the problems met in the welding of aluminum-magnesium alloys. Recommendations are made for the reduction of these difficulties and data is given on the properties of sound gas welds.

Discussion of Technical Papers on the Spot Welding of Light Alloys; Presented at the Third Session of the British Welding Research Association Symposium on the Welding of Light Alloys. *Sheet Metal Industries*, Vol. 24, No. 244, August, 1947, pp. 1650–1654, 1656.

The Pressing of Stainless Steel Exhaust "U" Pipes and Shrouds. T. W. Elkington. *Sheet Metal Industries*, Vol. 24, No. 244, August, 1947, pp. 1603–1608, illus.

Gloster Meteor. II—Front Fuselage Construction and Assembly: Outer Wings: Machining of Spar Booms. S. C. Poulsen. *Aircraft Production*, Vol. 9, No. 107, September, 1947, pp. 330–337, illus. (Cf. AER 11/47:45.)

The Aerosudest SE-2010 in Production. II. *Aircraft Engineering*, Vol. 19, No. 222, August, 1947, pp. 265–271, 276, illus. (Cf. AER 11/47:45.)

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DELCO-REMY—WHEREVER WHEELS TURN OR PROPELLERS SPIN

Production Problems of the DC-6. O. A. Wheelon. *Western Flying*, Vol. 27, No. 10, October, 1947, pp. 16, 17, 39, 40, illus. A detailed description of the changes in production-line organization and methods which were necessitated by conversion to peacetime production and by the particular design features of the DC-6.

The S.B.A.C. Show; Nearly 200 Firms at Radlett: Some Notes on Exhibits Likely to Interest the Production Engineer. *Aircraft Production*, Vol. 9, No. 107, September, 1947, pp. 352–357, illus.

Propellers

Charts for the Determination of the Performance of a Propeller Under Static, Take-Off, Climbing and Cruising Conditions. A. B. Haines, A. R. C. MacDougall, and R. J. Monaghan. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2086*, March, 1946. 47 pp., figs. 7 references. British Information Services, New York. $3.00.

Charts are given to determine the static and take-off thrust and also the propulsive efficiency of a propeller in the climbing and cruising conditions. Allowance is made for the effects of changes of solidity, number of blades, and tip speed. The charts are derived from data obtained from R.A.E. 24-ft. tunnel tests on conventional Clark Y-sectioned propellers having thickness ratios of 7.5 per cent and 12.5 per cent at 0.7 radius. For the static and take-off conditions, charts are also given for similar propellers of R.A.F. 6 section, and a correction is included for the effect of counterrotation.

Airscrews for Gas Turbines. II. L. G. Fairhurst. *Flight*, Vol. 52, No. 2016, August 14, 1947, pp. 163, 164, 172, diagrs.

A discussion of the special design problems presented by propeller-driven turbine aircraft. In order to avoid the increase in weight which would accompany the introduction of reduction gearing, the blade airfoil characteristics of the propeller have been improved to obtain higher efficiencies at higher tip and forward speeds. The central-entry turbine has necessitated either spinners of small diameters or special modifications to permit ducting of the intake air.

Investigation of Thrust Losses Due to Shanks of a Flared-Shank Two-Blade Propeller on a Slender-Nose Airplane. Jerome B. Hammack. *U.S., N.A.C.A., Technical Note No. 1414*, August, 1947. 14 pp., illus. 2 references.

Losses were found to be a function of the speed of the aircraft and to be relatively independent of blade loading. At velocities of 0.9 Mach, the losses were in the order of 9 per cent. A 19-per cent increase in spinner diameter reduced the thrust losses by about 60 per cent.

Summary Report on German Propellers (Project No. DP-154). E. A. Kadel. *U.S., Army Air Forces, Summary Report No. F-SU-1145-ND*, August, 1947. 73 pp., illus. 6 references.

A general description of the design, construction, and operation of the VDM, Junkers, and Argus propeller pitch-adjustment mechanisms. The VDM installation is normally electrically driven, but can be modified for hydraulic, pneumatic, or manual operation. It was used on all types of operational German military aircraft. It can be installed either as an automatic or a non-automatic pitch-change device. The Junkers design is hydraulically operated and was installed only with Jumo engines. In the Argus pitch-change mechanism, the pitch-change energy was derived from the relative movement of an air-driven vaned spinner and the propeller hub. It was used with Argus engines.

Plane Noise Reduction Progress Achieved in Research Project. Alexander McSurely. *Aviation Week*, Vol. 47, No. 17, October 27, 1947, pp. 35, 36, illus.

The Aeronautical Research Foundation, Inc., of Boston, is engaged in a propeller noise-reduction project financed by the N.A.C.A. A four-bladed propeller driven by a Franklin engine with reduction gearing has been successful enough to warrant further research on airplane mufflers produced by the Maxim Co., of Hartford, Conn., and an ejection-cooling muffler designed by Prof. Otto Koppen of M.I.T.

Propellers Aren't Noisy! John D. Waugh. *Airports*, Vol. 12, No. 2, August, 1947, pp. 24, 42.

Propeller noise can be reduced by using high-activity propeller-blade designs. The total noise of the aircraft can further be reduced by exhaust mufflers. High-activity blade design necessitates the use of reduction gearing. The problems of reduction gearing can be solved by the application of automotive practices.

Automatic Prop Feathering. *Aviation Week*, Vol. 47, No. 17, October 27, 1947, p. 32.

A sketch of the circuit and description of the operation of an automatic propeller feathering system designed by Consolidated Vultee Aircraft Corporation. A torque-pressure switch arms and activates simple electric circuits, which govern feathering, time delays, blocking relays, and indicator lights.

Automatic Prop Feathering Improves Payload of (Martin) 2-0-2. David Shawe. *American Aviation*, Vol. 11, No. 6, August 15, 1947, p. 32, diagr. (Cf. AER 11/47:47.)

Tailor-Made Props Fill Odd Needs. Leslie J. Trigg. *Aviation Week*, Vol. 47, No. 17, October 27, 1947, pp. 28, 30, 32, illus. A survey of some of the special-purpose propeller designs and development problems met by the Sensenich Corporation.

Radio and Electronics

Supersonic Delay Methods in Electronics. E. S. Henning. *U.S., Air Force, Air Technical Intelligence, Technical Data Digest*, Vol. 12, No. 8, October 15, 1947, pp. 5–9, diagrs.

The development of techniques such as radar, which employs the reflection of radio-frequency emanations as a basic principle, presented problems in the laboratory testing of such instruments and the instruction of operating personnel. In order to simulate the time element in the radiation echo, Kruse of the Telefunken Co. (Germany) developed a delay rod known as the "Rehbock." The pulse received from the antenna is converted into an intermediate frequency of about 25 mc. The intermediate frequency is used to excite a piezoelectric quartz crystal into mechanical oscillation. These supersonic oscillations are transmitted through a glass rod or other medium the length of which is determined by the echo time to be simulated. The supersonic waves are reflected from the end of the rod and travel back to the crystal, where they mechanically excite the quartz, which reconverts the supersonic waves into the original intermediate-frequency pulse. This device can be applied to the simulation of any electromagnetic radiation field.

Electrostatic Dischargers for Aircraft. Wayne C. Hall. *Journal of Applied Physics*, Vol. 18, No. 7, August, 1947, pp. 759–765, illus.

Static dischargers are a practical necessity on aircraft using present methods of radio communication. Wicks or trailing wires give good performance and are preferable to the heavy-particle type of discharger installation. A wick discharger invented and developed at the Naval Research Laboratory is described which was noise-free and could be applied to the aircraft at several points.

Investigation of Condensers for Interference Elimination on Air-Borne Electric Equipment. W. Thormann and R. Zechnall. (*ZWB/DLF/Jahr-40 s-III-1*, 1940.) *U.S., Army Air Forces, Translation No. F-TS-797-RE*, October, 1947. 31 pp., illus.

Electronic Micrometer. M. L. Greenough. *Radio News*, Vol. 38, No. 2, August, 1947, *Radio-Electronic Engineering*, pp. 11–13, 26, illus. 7 references.

The variation of mutual inductance between two coils in the vicinity of a metal surface is used to measure the thickness of the insulation that lies on that surface. A radio-frequency voltage is applied to the primary coil and the voltage induced in the secondary winding is read off on a microammeter calibrated in dimensional units. The accuracy of the instrument is better than 1 per cent. It has been used to read thicknesses as small as 100 millionth of an in.

Radiation Coupling of Two Dipoles with Reflectors. II. Grammeuller. (*Graefelfing, Flugfunk-Forschungsinstitut Oberpfaffenhofen, ZWB/UM/4021 T II*, November, 1944.) *U.S., Army Air Forces, Translation No. F-TS-1102-RE*, August, 1947. 32 pp., illus. 3 references.

A calculation of the connection points and quadripole data for the compensation cross member of a double dipole radar antenna. These connection points and proper base impedances remove the interference caused by radiation coupling.

Transmission Unit for D.F. Quadrantal Error Corrector. C. Plath. (*EIS/FSL/3/pla.*) *U.S., Army Air Forces, Translation No. F-TS-140-RE*, August, 1947. 8 pp., diagrs. A manufacturer's manual detailing the operation, installation, and servicing of a mechanical linkage and direct indicating unit that gives the quadrantal error correction for radio direction finders.

Lorenz Portable Transceiver TYP 54231. C. Lorenz. (*C. Lorenz Aktengesellschaft, EIS/Typ 54231.*) *U.S., Army Air*

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Forces, Translation No. F-TS-3152-RE, August, 1947. 4 pp., illus. The battery-powered 3-tube receiver and 2-tube transmitter operate on 454–500 mc. on MCW or voice with an output of 40–60 watts.

How Hughes Radar System Promotes Anticollision Flying. *Aviation Week*, Vol. 47, No. 14, October 6, 1947, pp. 37, 38, figs.

Statistical studies of contours of mountainous terrain under the principal airways show that a warning given when obstacles are present 2,000 ft. below the aircraft provide on the average 7.5 miles in which the pilot may climb to avoid mountains. The Hughes Radar System can be adjusted to give such a warning at 2,000 ft. and also at 500 ft.

Oboe—A Precision Radar System. M. G. Scroggie. *Radio News*, Vol. 38, No. 2, August, 1947, *Radio-Electronic Engineering*, pp. 6, 7, 21, figs.

A description of the operation, equipment, and basic circuits of a system that has been used for directing an airplane toward a ground target. The accuracy of the two ground stations and the airborne responder employed is extremely high and the main source of error in the employment of the system lies in the difficulty of maintaining high-speed aircraft on a true course.

Short-Distance Aids to Navigation: Australian Developments in Distance-Measuring and Multiple-Track Range Equipment. *Flight*, Vol. 52, No. 2016, pp. 155–157, illus.

A description of the ground and airborne equipment used in the short-distance navigation systems on the Sydney-Melbourne route in Australia. An airborne radar transmitter-receiver unit operating in the 200-mc. range has an automatic search and lock-on circuit that indicates on a dial the distance to the nearest radar beacon. A multiple-track range is produced by a pair of ground stations operating as master and slave in a manner similar to Gee but with ground stations from three to ten miles apart. A set of hyperbolas is produced which are effectively straight and radial over the operating region and offer up to 60 tracks, any one of which may be followed by the pilot.

Rotating Wing Aircraft

Some Aspects of Helicopter Economics. I, II. L. S. Wigdortchik. *The Aeroplane*, Vol. 73, Nos. 1887, 1888, August 8, 15, 1947, pp. 163–165; 186, 187; illus.

I. An analysis of the initial cost, power, pay load, and transmission efficiency of the helicopter, considered with reference to the operating cost per ton mile. Direct flying costs for flights of 20, 75, and 200 miles and comparative transmission efficiencies for various helicopter configurations are tabulated.

II. The choice of helicopter configuration depends on the relative importance of maximum lift and maximum cruising speed. The performance characteristics are determined by the rotor characteristics, the all-up weight, and the drag of the aircraft. Present trends favor maximum pay loads and the consequent reduction in cruising speed. The helicopter with tandem counter-rotating nonintermeshing rotors seems to offer the greatest development possibilities because it inherently gives less drag and cleaner lines than other configurations.

Practical Engineering of Rotary Wing Aircraft. XI, XII. Harris S. Campbell. *Aviation Week*, Vol. 47, Nos. 8, 14, August 25, October 6, 1947, pp. 20, 22; 29, 30; diagrs. (Cf. AER 9/47:63.)

XI. An analysis of blade-pitch and drag-pivot bearings as a guide to the selection of attachment bearings for rotor blades. Their function and operation is described for three rotor-mounting designs. **XII.** The normal life, the limit load, and the operating load are calculated for the drag and the flapping-pivot bearings.

A Preliminary Theoretical Study of Helicopter-Blade Flutter Involving Dependence upon Coning Angle and Pitch Setting. Robert P. Coleman. *U.S., N.A.C.A., Memorandum Report No. L6G12 (Wartime Report No. L-692)*, July, 1946. 14 pp., diagrs. 1 reference.

High-Speed Photographs of a YR-4B Production Rotor Blade for Simulated Flight Conditions in the Langley Full-Scale Tunnel. Richard C. Dingeldein and Raymond F. Schaefer. *U.S., N.A.C.A., Memorandum Report No. L5C12c (Wartime Report No. L-631)*, March, 1945. 23 pp., illus. 3 references.

Convertaplanes. R. R. Hays. *American Helicopter*, Vol. 8, No. 10, September, 1947, pp. 12, 13, 23, 24, illus.

A discussion of the possibility of designing an aircraft that would use wing-tip rotors to rise vertically. When the aircraft attained sufficient altitude, the rotors would tilt forward through 90° and function as conventional propellers.

Notes from Helicopter School. IV. Wolfgang Langewiesche. *Air Facts*, Vol. 10, No. 9, September 1, 1947, pp. 67–80, diagrs. (Cf. AER 11/47:48.) The effects of ground cushion, over-control, cross winds, and tail-rotor action on helicopter maneuvers.

N.A.C.A. and Bristol Rotor Test Towers. M. Berry. *American Helicopter*, Vol. 8, No. 10, September, 1947, pp. 18, 27, 28, illus. (Cf. AER 10/47:55.)

Seaplanes and Flying Boats

Impact Theory for Seaplane Landings. Stanley U. Benscoter. *U.S., N.A.C.A., Technical Note No. 1437*, October, 1947. 52 pp., diagrs. 8 references.

A smooth-water step-landing of a seaplane is analyzed by solving Newton's differential equation of motion entailing reasonable limiting assumptions. Formulas are developed for the maximum acceleration, the maximum draft, and the draft at the instant of maximum acceleration. The solution is dependent upon the definition of the apparent water mass. Approximate solutions for design use are represented graphically. Theory and experimental results are compared.

A Correlation of Loadings and Afterbody Length-Beam Ratios of Various Flying-Boat Hulls. John B. Parkinson. *U.S., N.A.C.A., Advance Restricted Report No. L6E28 (Wartime Report No. L-731)*, June, 1946. 7 pp., diagrs. 2 references.

The Effect of Amphibious Floats on the Power-Off Stability and Control Characteristics of a Twin-Engine Cargo Airplane. Steven E. Belsey and Roy P. Jackson. *U.S., N.A.C.A., Memorandum Report (Wartime Report No. A-73)*, January, 1943. 64 pp., illus. 1 reference.

The Longitudinal Stability of Flying Boats as Determined by Tests of Models in the NACA Tank. I—Methods Used for the Investigation of Longitudinal-Stability Characteristics. Roland E. Olson and Norman S. Land. *U.S., N.A.C.A., Advance Restricted Report (Wartime Report No. L-409)*, November, 1942. 39 pp., illus. 8 references.

Stress Analysis and Structures

Use of Vectors in Vibration Measurement and Analysis. Charles C. Kennedy and C. D. P. Pancu. *Journal of the Aeronautical Sciences*, Vol. 14, No. 11, November, 1947, pp. 603–625, diagrs. 18 references.

The authors' main concern with vibration measurement and analysis is the identification and description of the normal modes of vibration of an airplane for the purpose of checking calculated modes to be used in flutter analyses or in the computation of dynamic loads. A technique for using four vibrators to separate normal modes directly while testing is presented. The basis of the technique lies in the fact that a single normal mode can be immediately recognized as such by its property of having the same phase response relative to the force at all points on the airplane. The relation between responses is either 0° or 180° and remains such if the vibrator frequency is changed. The procedure consists of systematically sweeping the point of application and frequency of the applied force until the responses are found to be exactly in or out of phase. The method is absolutely valid for separating two symmetrical and two antisymmetrical modes having resonant frequencies close together. For more complex systems, a technique is given for the identification of normal modes on polar plots representing the variation of the response vector with forcing frequency. The basic element is that such a plot for a single mode is a circle. As the vibrator goes through a certain resonance, the tip of the total response vector describes an arc approaching that of the pure mode response. Identification of these arcs gives the normal modes, which might otherwise be confusingly located or completely hidden in the current practice of considering just the amplitude of the forced response. Miscellaneous new points include treatments of the specific disadvantages of rotary vibrators and the possibility of increasing the resonance sensitivity of the response measurements by differentiation with respect to the forcing frequency. Many other details of vibration analysis and record interpretation are given.

A New Fatigue Strength-Damping Criterion for the Design of Resonant Members. Joseph Marin and F. B. Stulen. *Journal*

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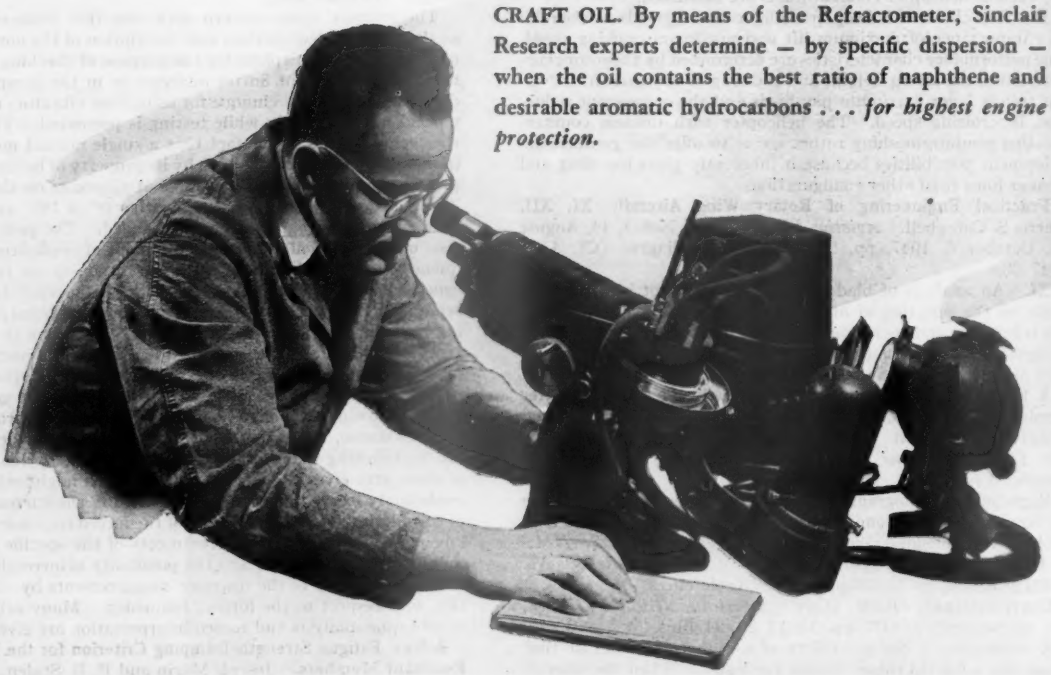

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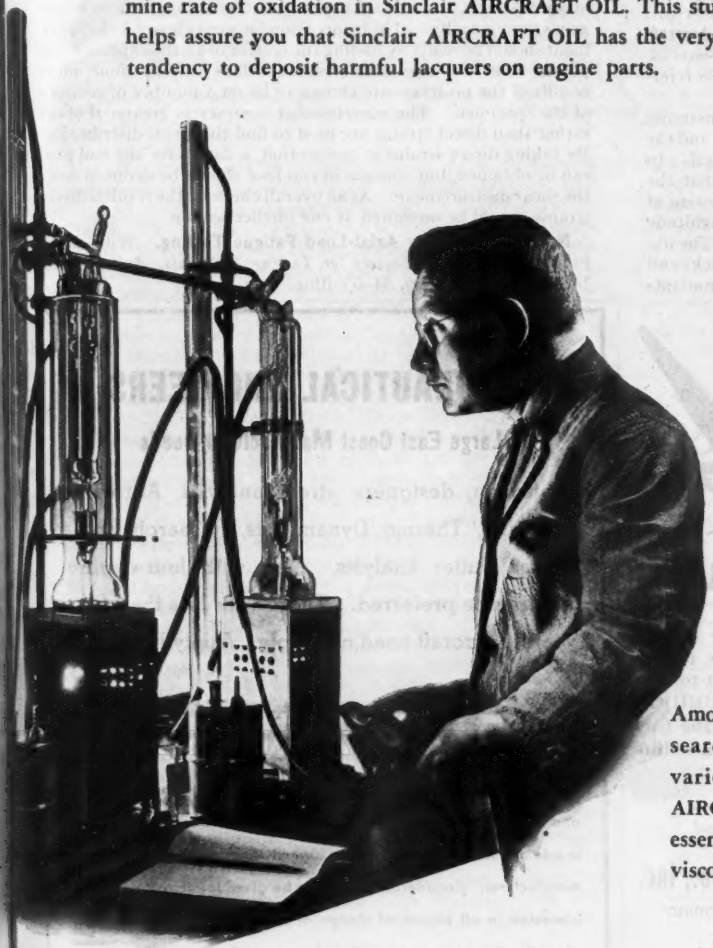

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of Applied Mechanics, Vol. 14, No. 3, September, 1947, pp. A-209–A-212, diagr. 3 references.

A theoretical analysis which shows that the load-resistance of resonant members of structures and machines is a function of the damping constant and the modulus of elasticity, as well as of the fatigue strength, of the material. The test data given show that the load resistance of a vibrating member may be changed appreciably by a correct selection of material when these design criteria are used. Design criteria are presented for vibrating beams and plates subjected to both concentrated and distributed resonant forces. Results are given for both internal and external damping. The method has application in the design of turbine and propeller blades.

A Theoretical Analysis of the Efficiency of Sandwich Construction Under Compressive End Load. W. H. Wittrick. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2016*, April, 1945. 20 pp., figs. 6 references. British Information Services, New York. $1.20.

A method of choosing the best core stiffness and thickness of skin and core to give optimum efficiency for any skin material and structural loading coefficient. The derivation of the loads that cause instability and the optimum analysis are made for sandwich struts in which the unloaded edges are completely free and for circular sandwich cylinders under end load. The core material is of the expanded foam type. There is a definite optimum foam stiffness for each skin material and structural loading coefficient.

Review of Current Methods for Strength Testing of Aircraft Wings. W. W. Johnstone. *Australia, Council for Aeronautics, Report No. ACA-28*, September, 1946. 34 pp., illus. 38 references.

A discussion of the methods and equipment used in Australia, America, and England. The mechanical loading method and the equipment developed by the C.S.I.R. are described in detail. In this technique, the loading stations are so positioned that the loads are directly proportional to the jack areas. A system of treeing is introduced by which a load of any reasonable magnitude may be applied at any desired station on the specimen. The use of hydraulic jacks and automatic equipment to load the jacks and to unload them at the maximum pressure makes this system adaptable to repeated loading tests. Appendixes treat of the constructional details of the C.S.I.R. test floor, the design of an hydraulic system applicable to small systems, the design of an hydraulic control valve, and methods of balancing the test rig and calibrating the indicating equipment.

Stability of an Aircraft Structure in a Strength Test Frame. P. B. Walker. *Royal Aeronautical Society, Journal*, Vol. 51, No. 440, August, 1947, pp. 704–714, diagrs.

The errors in load-measuring devices and the errors inherent in the jacks or other devices used to apply loads to test specimens give rise to an uncontrolled displacement of the specimen. An automatic control is proposed which will respond to this displacement and introduce stabilizing forces. Such a control would prevent uncontrolled positional displacement and eliminate the necessity of manual intervention.

The Investigation of Design Problems on Major Structural Components by Means of Static Strain Measurements. J. Taylor. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2129*, November, 1945. 15 pp., illus. British Information Services, New York. $0.90.

By using several hundred measuring positions on a major structural component, the strain distribution can be determined where rigorous calculation of the stresses is not practicable and compared with approximate theoretical distributions. A preliminary analysis should be made so that the positions can be spaced to use gages economically. The comparison between theory and experiment should be made by finding the scatter of all the experimental points from the theoretical curves. This can be done more readily if the positions are chosen to lie on a number of sections of the specimen. The experimental accuracy is greater if shear rather than direct strains are used to find the stress distribution. By taking direct strains at one section, a datum for the end load can be obtained, but changes in end load should be deduced from the shear measurement. As an overall check on the results, direct strains should be measured at one further section.

New Apparatus for Axial-Load Fatigue Testing. William N. Findley. *American Society for Testing Materials, Bulletin*, No. 147, August, 1947, pp. 54–56, illus.

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The Analysis of Strains Indicated by Multiple-Strand Resistance-Type Wire Strain Gages Used as Rosettes. Norris F. Dow. *U.S., N.A.C.A., Advance Restricted Report* (*Wartime Report No. L-536*), January, 1943. 19 pp., illus. 3 references.

Torsion and Shear Effects of Members Upon General Instability of Semimonocoque Structures Under Compression. Tsun Kuei Wang. *Journal of Applied Mechanics*, Vol. 14, No. 3, September, 1947, pp. A-177–A-182, figs. 9 references.

The basic theory of the instability of semimonocoque structures under compression is amplified by the inclusion of the torsional effects of rings and stringers and the shearing effect of the skin. The resulting formula is sufficiently general to cover longitudinal and radial variations of the structure. The final results are plotted as curves to facilitate practical application. The formula also serves as a criterion to determine whether the cross section of the structure under load will buckle into an elliptic shape or in a multilobe pattern.

The Behaviour of Structures Under Repeated Loads. A. G. Pugsley. *Royal Aeronautical Society, Journal*, Vol. 51, No. 441, September, 1947, pp. 715–720, figs. 10 references.

An examination of test results obtained with materials and structural elements having stress concentrations typical of aircraft structural practice. The behaviour of elementary structures under repeated loading indicates that the more or less continuous vibrations of wings and tailplanes during flight may produce effects that will set a period to the life of an airplane close to that estimated in commercial practice. The infrequent but wide fluctuations and reversals of load that occur may also produce similar effects.

On the Analysis of Statically Indeterminate Structures. W. S. Hemp. *College of Aeronautics, Cranfield, England, Report No. 3*, November, 1946. 8 pp. 1 reference.

Development of a general method of analysis. The problem treated is that of the determination of the load distribution in a structure for the general case in which the principles of statics alone are inadequate for a solution. The fundamental theorem of the method is a special case of the reciprocal theorem suitably generalized and extended. The validity of the method is demonstrated rigorously and recommendations are made for successful practical application. Particular cases, such as members in tension, bending, shear, or torsion, or under combinations of these stresses are covered by special formulas.

Recurrence Formulas and Differential Equations for Stress Analysis of Cambered Box Beams. Joseph Kempner. *U.S., N.A.C.A., Technical Note No. 1466*, October, 1947. 50 pp., diagrs. 5 references.

In contrast to the elementary theory of bending, shear deformation of cover and web is considered. The recurrence formulas are applicable to beams loaded by concentrated forces at intervals along their spans. The differential equation is valid for beams of constant section loaded at the tip and is solved for beams fixed at the root. For various methods of end restraint, boundary equations are developed which, together with the pertinent recurrence formula, yield a set of simultaneous linear algebraic equations. Solution of these equations provides correction forces that may be used in conjunction with the results of the elementary bending theory to determine the direct stresses in the stringers and the shear stresses in the skin. Comparison with experiments and with the results of other methods indicate that the stresses in cambered box beams may be adequately determined by the analysis.

The General Theory of Cylindrical and Conical Tubes Under Torsion and Bending Loads. V. J. Hadji-Argyris and P. C. Dunne. *Royal Aeronautical Society, Journal*, Vol. 51, No. 441, September, 1947, pp. 757–784, diagrs. (Cf. AER 5/47:55.)

The stresses and deformations of conical and cylindrical tubes under arbitrary loading. The axial constraint stresses may be calculated as if they are caused by torque about axes different in each mode. It is incorrect to calculate the axial constraint stresses from the torque about the flexural axis. Functions giving the crosswise distribution of stress are fully worked out for the n-boom tube of arbitrary cross section and for the singly symmetrical trapezoidal tube with continuous direct stress-carrying covers.

On the Application of the Energy Method to Stability Problems. Karl Marguerre. (*Deutsche Versuchsanstalt für Luftfahrtforschung, Jahrbuch*, 1938, pp. 252–262.) *U.S., N.A.C.A., Technical Memorandum No. 1138*, October, 1947. 41 pp., figs. 8 references.

For the Euler strut and the slightly curved beam under transverse load it is shown that problems of stability, as distinguished from problems of linearized elasticity theory, contain displacement terms higher than the second order in the expression of the

energy of deformation. Consequently, the energy method can be correlated in the special form most often used for stability investigations. The principle of virtual displacements can also be correlated in the version used in the general theory of elasticity. Elastic behavior can thereby be investigated beyond the critical deflection.

Euler's Classic Paper "On the Strength of Columns." J. A. Van den Broek. *American Journal of Physics*, Vol. 15, No. 4, July-August, 1947, pp. 309–318, figs. 7 references.

A summary history of the theory of columns and an analysis of the formula of Euler. The Euler theory is correct within its limitations, although it presupposes ideal pin-ended conditions that cannot be realized in practice. A modification is offered to solve the difficulty in the original formula in that the length of the column approaches zero when the load approaches infinity. A translation of Sections I to XVIII of "On the Strength of Columns," the original paper submitted by Euler to the Académie Royale des Sciences et Belles Lettres in Berlin in 1757, is given in full.

Proposed Experiments for Further Study of the Mechanism of Plastic Deformation. J. S. Koehler and F. Seitz. *Journal of Applied Mechanics*, Vol. 14, No. 3, September, 1947, pp. A-217–A-224, diagrs. 28 references.

The assumption that imperfections, called dislocations, grow and move through a crystal when it is subjected to sufficiently large shearing stresses is a satisfactory qualitative explanation of the mechanism of plastic deformation. The activation energy associated with the potential barrier met by a dislocation and information on the ends and on the distribution of dislocations may be obtained from measurements of the internal friction, the electrical resistance, and the rate of creep performed on a spectroscopically pure metal single crystal. Stress-strain curves obtained on fine single-crystal wires may provide information on the effective size of cracks, on the relation between yield strength and the size of the cracks, and on stress magnification at cracks. A measurement of the electrical resistance of a well-ordered binary alloy that is undergoing creep at very low stresses and temperatures may make it possible for the passage of a dislocation along the slip plane to be detected. The imperfections responsible for plastic deformation may possibly be observed directly in the Laue X-ray diffraction pattern of a silver chloride crystal that has been subjected to plastic deformation and subsequently exposed to light.

A Concentrated Force Problem of Plane Strain or Plane Stress. A. E. Green. *Journal of Applied Mechanics*, Vol. 14, No. 3, September, 1947, p. A-246.

The solution for a large plate containing an elliptical hole and loaded by line forces at the ends of the minor axis of the ellipse is obtained in closed form by using complex variable analysis.

Camptograms for Beams in Compression. V. Rojansky and R. A. Beth. *Journal of Applied Mechanics*, Vol. 14, No. 3, September, 1947, pp. A-202–A-208, figs.

A curve representing a uniform beam in axial compression carrying a uniformly distributed transverse load is obtained when the bending moment differential is plotted against a quantity proportional to the ratio of the bending moment differential and differential of the length of the axis. From this curve the bending moment can be evaluated. Examples of the construction are given which include external torques, concentrated transverse loads, built-in ends, stepwise variation of distributed load, stepwise variation of flexural rigidity, and a protruding end. The method, which may also be used to represent the slope and the deflection of the beam, is a simpler construction, and is simpler to interpret than the conventional polar diagrams.

Stress Concentration Around an Ellipsoidal Cavity in an Infinite Body Under Arbitrary Plane Stress Perpendicular to the Axis of Revolution of the Cavity. M. A. Sadowsky and E. Sternberg. *Journal of Applied Mechanics*, Vol. 14, No. 3, September, 1947, pp. A-191–A-201, figs. 7 references.

A closed solution is obtained by extension, to orthogonal curvilinear coordinates, of the classical three-function approach to three-dimensional problems of the theory of elasticity. The basic solution is applied to the problem of the spheroidal cavity in a plane hydrostatic state of stress and in a plane state of pure shearing stress. The solutions obtained for the prolate spheroidal cavity are shown to remain valid for the oblate cavity.

Effect of Variation in Diameter and Pitch of Rivets on Compressive Strength of Panels with Z-Section Stiffeners: Panels of Various Lengths with Close Stiffener Spacing. Norris F. Dow and William A. Hickman. *U.S., N.A.C.A., Technical Note No. 1421*, September, 1947. 17 pp., illus. 3 references.

The panel proportions were limited to the region of existing design charts for 24S-T aluminum alloy in which the stiffener spacing is smallest and the width-to-thickness ratio for the web of the stiffeners is least. The effect of riveting on the strength depended on the type of panel failure. Short panels that failed by local buckling increased appreciably in strength with either an increase in the diameter of the rivets or a decrease in the rivet pitch. The strength of the panels of intermediate length which failed by a combination of local buckling and column bending was less affected by changes in riveting. The strength of the long panels that failed by column bending showed some tendency to decrease with an increase in the strength of the riveting, probably as a result of greater initial curvature induced in the panel by the greater number or greater size of rivets.

Analytic and Experimental Investigation of Bolted Joints. Samuel J. Rosenfeld. *U.S., N.A.C.A., Technical Note No. 1458*, October, 1947. 48 pp., illus. 7 references.

An analytical method for calculating the distribution of the loads between the bolts of a joint. The equations are given in the form of a recurrence formula, a finite difference equation, or more approximately as a shear lag formula. Tests were made with five and nine bolts in line.

Effect of Variation in Diameter and Pitch of Rivets on Compressive Strength of Panels with Z-Section Stiffeners: Panels of Various Stiffener Spacings that Fail by Local Buckling. Norris F. Dow and William A. Hickman. *U.S., N.A.C.A., Technical Note No. 1467*, October, 1947. 27 pp., illus. 4 references.

Results of tests on panels of 24S-T aluminum alloy showed that the local buckling strengths increased appreciably with either an increase in diameter or a decrease in the pitch of the rivets.

A Preliminary Study of Compressive Load on the Fairness of a Low-Drag Wing Specimen with Z-Section Stiffeners. Eastman N. Jacobs, Eugene E. Lundquist, Milton Davidson, and John C. Houbolt. *U.S., N.A.C.A., Confidential Bulletin (Wartime Report No. L-527)*, January, 1943. 8 pp., illus. 3 references.

Compressive Strength of Corrugated-Sheet-Stiffened Panels for Consolidated XB-36 Airplane. Robert A. Weinberger, William C. Sperry, and Charles V. Dobrowski. *U.S., N.A.C.A., Memorandum Report (Wartime Report No. L-588)*, January, 1944. 13 pp., illus. 2 references.

Compressive Strength of 24S-T Aluminum-Alloy Flat Panels with Longitudinal Formed Hat-Section Stiffeners Having a Ratio of Stiffener Thickness to Skin Thickness Equal to 1.00. William A. Hickman and Norris F. Dow. *U.S., N.A.C.A., Technical Note No.* 1439, September, 1947. 20 pp., illus. 8 references.

Results of part of a test program on 24S-T aluminum-alloy flat compression panels with hat-section stiffeners. The results show the effect of the relative dimensions of a panel on the buckling stress and average stress at maximum load. Comparative envelope curves provide some indication of the relative structural efficiencies of hat- and Z-stiffened panels having a ratio of stiffener thickness to skin thickness of 1.

Dynamic Loads on Airplane Structures During Landing. M. A. Biot and R. L. Bislinghoff. *U.S., N.A.C.A., Advance Restricted Report 4H10 (Wartime Report No. W-92)*, October, 1944. 56 pp., diagrs. 5 references.

Wind Tunnels and Laboratories

Two-Dimensional Supersonic Channel Design. I. A. O. L. Atkin. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2174*, November, 1945. 8 pp., figs. 3 references. British Information Services, New York. $0.60.

A method of designing channels to convert uniform supersonic flow of any Mach Number into uniform supersonic flow of any other Mach Number. The theory is exact, neglecting the boundary layer. The tables given enable all parts of the channels to be calculated quickly with high accuracy. Use is made of a construction first given by Busemann in 1931 for transforming divergent radial flow into a uniform stream; an exact analytic expression has been found for this method. The method of "analytical characteristics" used can be applied to any type of supersonic flow and is not restricted to purely radial flow. Details of the calculations involved are given. Symmetrical channels only have been considered, but any two walls that give the same velocity along the axis can be used.

Cautionary Note Regarding Some Chemicals Used for Transition Indication. R. C. Pankhurst. *Royal Aeronautical Society, Journal*, Vol. 51, No. 439, July, 1947, pp. 651, 652. 6 references.

The continued use of toxic chemicals in the spray painting of wing surfaces or as reactants in transition tests may build up sufficient concentrations of the vapor in the wind tunnel to have toxic effects on the operating personnel. Various chemicals now in use and their properties are listed.

A Method for Obtaining Quantitative Information in Towing Basins. Donald H. Jacobs. *The Review of Scientific Instruments*, Vol. 18, No. 7, July, 1947, pp. 523, 524, illus. 2 references.

Dye is added to the water in a towing basin to cause an appreciable absorption of the light transmitted vertically through it. Waves produced by the movement of a test body, when photographed from above, display a light and dark pattern that corresponds to the height of the crest and the depth of the trough. Photometric measurement of the density of the photographic negative can be used to determine with an error as low as 1 per cent the height of the waves.

Optical Systems for Studying Air Flow. K. W. Todd. *The Aeroplane*, Vol. 73, No. 1890, August 29, 1947, pp. 246, 247, illus.

An explanation of the shadowgraph, Toepler-schlieren, and the Mach interferometer systems, all of which depend on local changes in the index of refraction of a fluid for visualization of shock waves. The systems are compared as to their practicability in the quantitative and qualitative determination of the conditions in fluid flow.

An Approximate Supersonic Wind-Tunnel Simulator. Allen H. Schooley. *American Journal of Physics*, Vol. 15, No. 2, March-April, 1947, pp. 164–171, illus. 5 references.

Two small containers are connected by a spillway. A constant head of water is maintained in one to provide a uniform flow in the spillway. Lift and drag characteristics exhibited by scale models floated in the water give an approximate indication of their characteristics in an air stream. The quantities that effect the drag of a floating body are analyzed and formulas are worked out for calculating the drag that would occur in the air. Tests conducted with a model missile and a model wing are described in detail. The drag was found to be greater and the lift less than that of the full-scale model, but the shape of the coefficient curves was similar. Further development of the technique should make it a practical method of producing qualitative simulation of wind-tunnel effects.

Special Cameras and Flash Lamps for High-Speed Underwater Photography. Robert T. Knapp. *Society of Motion Picture Engineers, Journal*, Vol. 49, No. 1, July, 1947, pp. 64–82.

A description of the cameras and flash lamps and their installation as used by the Hydrodynamics Laboratory of the California Institute of Technology in the analysis of the underwater motion of solid bodies. An endless film belt travels at the speed of approximately 35 ft. per sec. and gives a 1-sec. exposure. The camera contains no shutter mechanism.

All the World's Weather Packed Under One Roof. *Popular Science Monthly*, Vol. 151, No. 3, September, 1947, pp. 138–142, illus., diagrs. (Cf. AER 10/47:59.)

The Air Forces Climatic Hangar at Elgin Field, Fla., can simulate a climate ranging in temperature from —70° to 165°F. for testing aircraft power plants, instruments, and personnel equipment. All-weather rooms are provided where equipment can be tested under various conditions of atmospheric density, pressure, and humidity.

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Technical Aerodynamics. Karl D. Wood. 2nd Ed. New York, McGraw-Hill Book Co., Inc., 1947. 472 pp., diagrs., figs., tables. $5.50.

Because of the advances in aerodynamics made during the past twelve years, this new edition of a book published in 1935 bears little resemblance to the original. The material in the first edition has been thoroughly revised and brought up to date by the addition of information that was only recently declassified. The extent of the revisions and the inclusion of the results of wartime aerodynamic research have increased the size of the volume and enlarged its scope. The first edition was intended for a single three-credit course of about 45 lessons. The new edition contains material for two such courses. Prerequisites for the courses include the completion of four 16-week terms of college instruction in engineering and a good background in physics and mathematics.

The introduction constitutes a simple review of the most important superficial aspects of aircraft and provides a clear picture of present-day aircraft construction and operation. The first chapter outlines the fundamental principles of fluid mechanics and thermodynamics. Consideration is then given to airfoil characteristics, parasitic drag and the power required for flight, engine and propeller characteristics, and airplane performance. There are chapters on seaplanes and flying boats, flight testing, the characteristics of hinged surfaces, and stability and control. The opening section of the chapter on engine and propeller characteristics covers such topics as the general principles of internal-combustion engine design and operation and indicator diagrams. This survey of airplane-engine operation is intended chiefly as a background of nomenclature for an explanation of the principal characteristics that affect airplane performance.

Professor Wood had succeeded in presenting the elements of a highly technical subject in a form that should be easily understood by the average engineering student. In addition to clarity of presentation, a characteristic of all the author's books, the text contains excellent illustrations and is printed in readable type on a good quality of glazed paper. Those who have had to search through many pages of engineering works to determine the meaning of certain abbreviations will appreciate the extensive list of abbreviations immediately following the table of contents. Included in the six appendixes are units and conversion factors, data on the properties of liquids, gases, and air, and data on airfoils, parasitic drag, propellers, and engines. The appendix on airfoil data should be useful for reference, since it brings together in one place information on foreign airfoils, such as the Göttingen series, previously scattered in individual reports, and since it includes a great amount of data on airfoils recently released from classified status by the N.A.C.A.

The Escalator Method in Engineering Vibration Problems. Joseph Morris. New York, John Wiley and Sons, Inc., 1947. 270 pp., figs., tables. $4.50.

Of the greatest interest and importance is this exposition of new methods of dealing with strength and vibration. The author is Consultant, Structural and Mechanical Engineering Department, Royal Aircraft Establishment, Farnborough. The volume contains material that heretofore has been accessible only in original scientific papers, many of which were not available to the general public. The escalator method is an effective device for attacking vibration problems. Specifically, it was devised to make Lagrangian frequency equations numerically tractable. The method makes it possible to treat a complicated system in a simple manner, by dealing with its constituent parts. The solution of each of the parts is made available with appropriate linking coordinates or reactions. The complete system is solved in manageable form by the elimination of these linkages. The book deals also with other methods of computation, the theory of elasticity, general reciprocal theorems, and methods of strain energy and least work.

Chapters 1 to 7 give a résumé of means of treatment which have been found successful in dealing with problems concerning the strength and stiffness of structural frames, including the Hardy Cross moment distribution method. In Chapter 8 a brief account is given of devices for approximating frequencies of vibration, and this is followed by a chapter on the vibration of rotating shafts. The analytical foundation of the escalator process for the solution of Lagrangian frequency equations is described in Chapter 10, while Chapter 11 sets forth the basic principles of its application to vibration problems and explains how it may be used for the linking up of frequency equations by parts. The four chapters that follow will be found to be of great interest to engineers dealing with vibration in aircraft power plants. These chapters discuss the treatment of the torsional vibration of engine crankshaft systems; the vibration of tapered rods resembling propeller blades; coupled engine crankshaft torsional and propeller blade flexural vibrations; and the linking up by the escalator process of multiple propeller and gear systems. Of importance to the air-frame designer are the next three chapters which describe means for dealing with the analytical treatment of aircraft vibration. Consideration is given to wings, coupled fuselage roll and anti-symmetric wing vibration, and pitching and yawing vibrations and their coupling by propeller vibration. A rational approximation is included for taking into account the flexibility of the blades of a propeller in gyroscopically coupled vibration. In the four remaining chapters the author returns to the subject of vibration in power plants. The nature of the forcing vibrations arising from the firing in the cylinders is formulated. The periodicity of the forced vibrations due to the passing of aerodynamic obstacles by propeller blades is discussed. A solution is given to the problem of coupled engine crankshaft torsional and propeller blade flexural vibrations in which account is taken of forced vibration and damping. The principle of the pendulum dynamic vibration dampers is elucidated. The three appendixes contain information on a method that has been found useful for numerical integration, the fundamental frequency of vibration of

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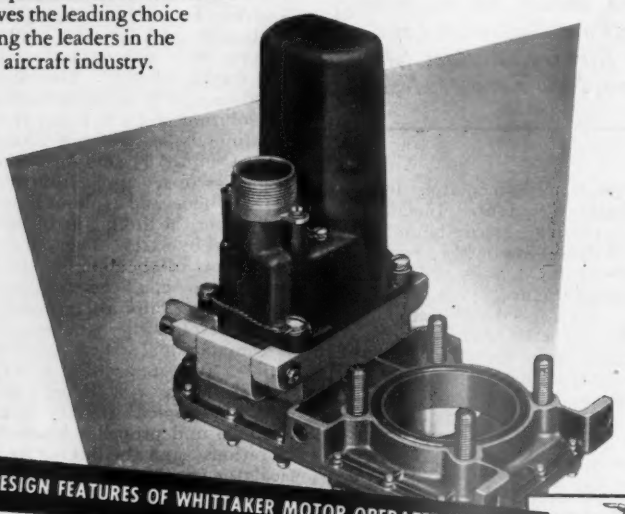

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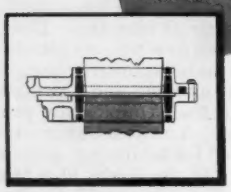

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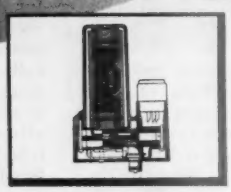

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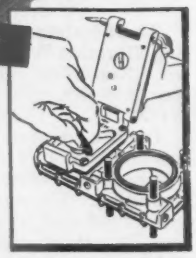

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a freely supported rod of variable section, and the effect of flexibility of propeller blades on gyroscopic couples in a turn. There is an index of authors mentioned in the text and an adequate subject index.

Aerothermodynamics; Notes on Twelve Lectures Given in the Department of Physics, Columbia University, by Theodore von Kármán. Prepared by William Perl. New York, Columbia University, September, 1947. 120 pp., figs. Mimeographed.

A condensation of twelve lectures on compressible fluids presented to give orientation in the principles involved. They deal with those phenomena that involve a combined discussion of fluid dynamics and thermodynamics. Following an introductory review of the equations of motion and the conservation laws, the author discusses the propagation of small disturbances and the thermodynamic properties of fluids; one-dimensional gas dynamics and normal shock; nozzle flow with shock and oblique shock waves; the Prandtl-Meyer flow; the hodograph method for steady two-dimensional flow; applications of the hodograph method; small perturbation methods for compressible flows; viscosity, stress, and rate of strain; equations of motion including viscosity and heat conduction; and boundary layer. Exercises and problems accompany the text of each lecture.

Gas Turbine Construction. R. Tom Sawyer. New York, Prentice-Hall, Inc., 1947. 411 pp., illus., diagrs. $7.00.

This book may not be considered exactly as a treatise on gas-turbine design nor as a college text. It is devoted almost entirely to engineering descriptions of gas turbines, for various services, with information about their operation and maintenance. The author was for many years associated with the service and engineering departments of the General Electric Company and is now with the American Locomotive Company, where he specializes in Diesel-locomotive application and design. A considerable portion of the book will not be of direct interest to the aircraft-engine designer. This is true of Part I, which is devoted to heavy equipment for use in stationary, marine, or locomotive service. Part II deals with turbochargers and turbosuperchargers, now widely used for supercharging all types of internal-combustion engines. Included are chapters giving detailed particulars about the B-31 turbosupercharger for aircraft engines, designed by the General Electric Company and aircraft-engine turbosuperchargers produced by the Wright Aeronautical Corporation. There is an interesting chapter on the testing of turbosuperchargers, with descriptions of test equipment, experimental testing methods used in connection with the development of a design, and a few remarks on the testing

of production units after assembly. The remainder of the book is devoted to construction and service information about American, British, and German gas-turbine equipment for aircraft. The specifications of the gas turbines produced by these countries are listed in tabular form. The book should be of great interest to those in the aviation industry who wish to keep up with the latest developments in gas-turbine construction. The gas-turbine engineer will find the volume of value for reference purposes.

Airline Traffic Survey, September, 1946. Vols. 1–5, Origination-Destination Airline Traffic Survey of Revenue Passengers. Vol. 6, Station-to-Station Airline Traffic Survey of Domestic Revenue Traffic by Classes. U.S., Civil Aeronautics Board, Economic Bureau, Analyses Division. Washington, U.S. Govt. Printing Office, 1947. 2,056 pp., maps. Vol. 1, $0.50; Vols. 2–5, $1.25 each; Vol. 6, $1.00.

Issuance of the Air Traffic Survey for September, 1946, by the Civil Aeronautics Board resumes the semi-annual series instituted before the war and discontinued during the war years. Available to the general public for the first time through the Government Printing Office, the material now is published in 8 by 10-in. volumes that are more convenient to handle.

The report is presented in two principal parts, the Origination-Destination Airline Traffic Survey of Revenue Passengers, which is covered in Volumes 1–5, and the Station-to-Station Airline Traffic Survey of Domestic Revenue Traffic Classes, which is presented in Volume 6. Included in Volume 1 are maps and summary tables covering the origination-destination survey. Volumes 2–5 present the station detail of passenger originations and destinations in domestic and United States' Canadian transborder traffic. Volume 6 contains the maps and the details of the station-to-station survey.

The origination-destination survey includes all revenue passengers ticketed during September, 1946, for scheduled air journeys on routes of certificated air carriers within the United States and between the United States and Canada. The station-to-station survey includes revenue traffic flow by classes—passenger, mail, express, and freight, moving along domestic routes operated by the certificated domestic air carriers of the United States. Because of the large number of flights operated in September, 1946, the individual flight data shown in prewar survey reports were omitted from basic survey schedules. However, additional material covering capacity available and load factors is presented.

Other Books Received

AIR TRANSPORT

Airline Traffic and Operations. Morris B. Baker. Prepared under the Supervision of the Publications Division, The Academy of Aeronautics, N.Y. New York, McGraw-Hill Book Co., Inc., 1947. 430 pp., illus., facsims. $4.50. Those who contemplate a career in the commercial air-line industry will find that this practical text contains a wealth of helpful information and data on air-line traffic and operations. The author is employed as industrial engineer by TWA, and he describes in nontechnical language the various types of work involved in the operation of an air line, the reasons for the methods used, and the duties of those who perform the work.

Beginning with the city ticket office, the author discusses air-line ticketing and routing, air-travel insurance, reservations procedure, air traffic sales, and the duties of the air-line hostess. Air-line operations policies, regulations, and procedures are set forth. There are chapters on the air-line pilot, air-line mechanic, loading the airplane, air mail, air express, and air freight. The national air-mail pick-up system proposed by D. V. Seevers is described in considerable detail. Consideration is given also to air-line publicity and public relations. Appendixes contain particulars about U.S. government agencies, domestic and foreign air-mail carriers, reservation codes, and training films. Flight coupons, baggage tags, and report forms are reproduced in facsimile.

Skyways of the Pacific. Weldon B. Gibson. (I.P.R. Pamphlets No. 27.) New York, American Institute of Pacific Relations, 1947. 48 pp., map. $0.25. Expansion of service; geography; wartime progress; existing and planned air services; international agreements; political considerations; economics and the Pacific skyways; and travel, trade, and culture by air. The author was formerly Dean of the A.A.F. Institute of Technology and is now with Stanford University.

The German Commercial Air Transport Industry and Related Aeronautical Activities and Developments. Robert E. Avison, J. H. Carmichael, Harold E. Gray, O. E. Kirchner, E. J. Minser, C. A. Petry, E. H. Schroeder, and Kenneth Ward. (Combined Intelligence Objectives Sub-Committee, Item Nos. 25, 26, 27, 28, File No. 32-24.) London, H. M. Stationery Office; New York, British Information Services, 1946. 552 pp., illus., diagrs. $12.20. An extensive evaluation based on inspection of facilities and interrogation of executive and technical personnel. The operating methods, policies, equipment, and other facts regarding the government-subsidized Deutsche Lufthansa organization were the subjects of the investigation. Because of government sponsorship, the Deutsche Lufthansa was not subjected to regulation and competition and was allowed to establish its own standards of service and rates. Its compact territory and the conditions under which it operated make comparison with American air lines difficult, but in general its equipment and methods were inferior to those of American companies. The report gives detailed descriptions of the organization, financial and personnel policies, meteorology, flight operations, aircraft equipment, maintenance and overhaul procedures, airports and airways, and the operations of the German Air Transport Command. A list of specific questions submitted by the American air-transport industry and other interested agencies and the answers obtained by the investigators are reproduced in full. The questions and answers cover a wide range of subjects including airplane and engine design, maintenance facilities, passenger service; personnel training, medicine, and accounting and finance.

Aircraft Use in 1946; Preliminary Report, October, 1947. U.S., Civil Aeronautics Administration, Research Division and Office of Aviation Information, Washington, 1947. 16 pp. A preliminary report on an analysis of answers received in personal interviews and questionnaires on the amount and type of flying, in the calender year 1946, of all U.S. aircraft other than those operated by the C.A.A. or the scheduled air lines.

University Courses in Air Transportation. Donald F. Mulvihill. University, Ala., Bureau of Business Research, University of Alabama, 1947. 34 pp., tables. The results of a survey carried out to determine the kind of air transport courses offered by the various universities in the academic year 1945–1946.

AIRPLANE OPERATION

Flight Engineers Manual, With Representative Multiple-Choice Questions and Answers for the Flight Engineer Examination. Charles A. Zweng. North Holywood, Calif., Pan-American Navigation Service, 1947. 416 pp., illus. $4.00. The purpose of this manual is to help candidates prepare for the written part of the examination for the rating of flight engineer. Aerodynamics theory of flight, aircraft and engine operation, maintenance, fuel consumption, loading and balance, center of gravity determination, engine computations, and Civil Air Regulations are included in the discussion. About one-third of the book consists of selected data from the operating manuals of the Boeing Stratoliner 307-B1, the Douglas DC-4, and the Lockheed Constellation. The text is followed by 240 questions, with answers. There is an index referring to the text.

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AIRPORTS

Louisiana Airports. Louisiana Department of Public Works, Aeronautics Division, Baton Rouge, La., October 1, 1947. 22 pp., tables. An alphabetical list describing commercial, private, and Army airfields.

Directory of State Aviation Officials, and Officials of Civil Aeronautics Administration Concerned with Airport Development. Washington, American Road Builders' Association, 1947. 40 pp., map.

DRAFTING

Problems in Drafting and Design. F. L. Goff. Bloomington, Ill., McKnight and McKnight, 1947. 117 pp., illus., diagrs. $1.00. A students' workbook providing a first course in drafting. The 50 graded problems are based on current aircraft manufacturing practices. The photographic illustrations give a good insight into production methods and processes. Each problem is followed by several references to more advanced textbooks on the subject.

ELECTRICITY AND RADIO

Technical Papers on Equipment and Systems Demonstrated at R.A.F. Transport Command, Bassingbourn, Telecommunications Research Establishment, Great Malvern, and The Royal Aircraft Establishment, Farnborough, September 8 to 25, 1946. Provisional International Civil Aviation Organisation. Farnborough, Hants., England, The Royal Aircraft Establishment, 1946. 3 Vols., 276, 292, 277 pp., illus., diagrs.

Those concerned with radio for civil aviation will find a great deal of valuable technical information in this collection of papers. The three large volumes are bound in loose-leaf form and contain 48 papers on long- and short-range navigational aids, communications systems and equipment, and accessory apparatus and techniques. Information is given about position indicators, navigation computers, warning equipment, various navigation systems, radio beacons, low-power airborne equipment, ground equipment, V.H.F. communication equipment, various types of receivers and transmitters, training apparatus, equipment for testing apparatus under various climatic conditions, control-tower design, telecommunications service, aircraft antennas, and other subjects. There are many excellent photographs, schematic diagrams, and charts. The papers were prepared by the Ministry of Supply; Ministry of Civil Aviation; Standard Telephones and Cables, Ltd.; General Electric Co., Ltd.; Pye, Ltd.; Marconi's Wireless Telegraph Co., Ltd.; and Ultra Electric, Ltd.

A Course in Electrical Engineering. II—Alternating Currents. Chester L. Dawes. 4th Ed. New York, McGraw-Hill Book Co., Inc., 1947. 708 pp., diagrs. $5.00. The revised edition of a standard textbook for students of electrical engineering. A knowledge of d.c. theory is presupposed. Although mathematics has been introduced, the book is elementary in that it is intended to serve as an introduction to more advanced works in the series. Wartime developments and modern practice in a.c. circuits, instruments, alternators, transformers, motors, rectifiers, electron-tube theory and application, and frequency modulation have been drawn upon as sources for additional material. There are useful appendixes and a good index. The section of "Questions and Problems" now covers 79 pages.

Principles of Electrical Engineering. Vol. I—Heavy-Current and Light-Current Engineering Practice. Vol. II—Problems and Their Solutions. T. F. Wall. Brooklyn, N.Y., Remsen Press Division, Chemical Publishing Co., Inc., 1947. 562, 312 pp., figs. $8.50, $5.00.

I. A comprehensive text for students with a knowledge of calculus and the use of vectors. Some of the subjects dealt with include the development of standard units of measurement; insulation technique; recently developed magnetic materials; the use of complex quantities and their application; graphical methods for the solution of technical problems; "skin effect"; the principles of long-distance high-tension transmission of electrical energy; and basic facts and fundamental equations relating to the propagation of electromagnetic waves through space. A collection of test papers is included, which have been chosen to emphasize the different aspects of the principles discussed. II. A collection of over 200 problems based, for the most part, on the material presented in Vol. I. The solutions are worked out in detail and are accompanied by explanatory drawings. In the cases where the examples go beyond the scope of the principles given in the text, reference is made to periodical literature that contains fuller explanations.

ENGINES

Power Plants: Project Book. East Saint Louis, Ill., Parks Air College, 1946. 190 pp., diagrs. This book is a combined syllabus, lesson plan, and shop manual for a course in aircraft engines and accessories. Fourteen models of aircraft engines with horsepower ranging from 50 to 1,700, and of the opposed, in-line, and radial types are taken down and reassembled in the first part of the course. This phase aims not only to develop the student's mechanical facility but also to give him a practical knowledge of the materials used on the individual components, the design and construction of the engine, and the lubrication system. Aircraft electric power-supply, power-control, and starter systems; fuel-supply and carburetion systems; and ignition systems are taken up in subsequent parts. Each phase of the course consists of a series of independent projects, each devoted to a specified type and make of engine or accessory. The work of the student is outlined step by step and necessary explanatory notes or text are introduced as the need arises.

Engine Overhaul and Trouble-Shooting. East Saint Louis, Ill., Parks College of Aeronautical Technology, St. Louis University, 1947. 100 pp., illus., diagrs. The aim of the book is to give the student a sufficient understanding of the steps in disassembly, reassembly, and servicing of an engine so that, guided by a manufacturer's manual, he will be able to cope with the unique problems and variations in technique required by specific engines. As the step-by-step process, which in-

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cludes not only cleaning and inspection but also servicing and timing, is described, special tools and their use are explained. No presumption is made as to the student's general knowledge of the subject. Explanations of methods or systems are detailed, and are, in all cases, accompanied by an elementary treatment of the basic theory pertaining to their use of operation. The check lists in the trouble-shooting section indicate symptoms, possible causes, and methods of checking.

Motoren (Engines). Hans Zumbühl. Zurich, Schweizer Druckund Verlagshaus, 1946. 277 pp., illus., diagrs. Sw. fr. 9.50. (In German.) A clearly written historical and expository summary of heat engines of all types—steam engines and turbines, Diesel engines, Otto-cycle engines, gas turbines, and rockets. Theory of operation, constructional details, applications, and fuels are described. The book was prepared as an introduction for the interested layman and only simple mathematical expressions have been introduced. The numerous photographs and line drawings are clear-cut and informative.

FLIGHT TECHNIQUE

Radio and Instrument Flying. Charles A. Zweng and Allan C. Zweng. North Hollywood, Calif., Pan-American Navigation Service, 1947. 357 pp., illus. $4.00. This revised and enlarged edition includes new chapters on the Dalton E-6B Computer and on "Altitude Instrument Flight." New material on the use of radio charts, the international station model for use on synoptic weather maps, and C.A.A. regulations on controlled flight on instruments is included, and the question and answer section has been completely revised. The book includes all subjects of government tests for pilots' instrument ratings and for the radio-telephone operator's permit.

HISTORY

A Historical Summary of the Royal Aircraft Factory and Its Antecedents: 1878–1918. S. Child and C. F. Caunter. (Report No. Aero. 2150.) Farnborough, Hants., England, Royal Aircraft Establishment, March, 1947. 72 pp., illus., tables. A concise review of the work of the Royal Aircraft Factory, which became the Royal Aircraft Establishment in 1918, and its development from the Woolwich Arsenal Balloon Equipment Store, established in 1878. Important events are listed chronologically and changes in organization and personnel are recorded. Tables give brief descriptions and specifications of the 125 airships, airplanes, and engines built at the R.A.F. up to 1918. Photographs of the aircraft, engines, and personnel have been reproduced whenever available.

LANDING GEAR

Tire and Rim Association 1947 Yearbook: Airplane Section. Akron, Ohio, The Tire and Rim Assn., Inc., February, 1947. 46 pp., diagrs. $0.75. Data on different types of airplane tires, rims, and valve fittings, including tire ratings, inflated dimensions, and rim dimensions.

LAWS AND REGULATIONS

Civil Air Regulations for Pilots. Charles A. Zweng and Allan C. Zweng. North Hollywood, Calif., Pan American Navigation Service, 1947. 41 pp. $1.00. A collection of the latest Civil Air Regulations of interest to ground and flight instructors, pilots, and prospective pilots. The text is divided into nine sections: Pilot Regulations, Visual Flight Rules, Instrument Flight Rules, Aircraft Certification and Registration, Acceptable and Non-Acceptable Articles for Air Transportation, Penalties, Definitions, Index to the Civil Air Regulation Parts, and Exchange of Military Pilot Certificates and Ratings.

A.S.T.M. Standards on Adhesives. Philadelphia, American Society for Testing Materials, July, 1947. 42 pp., diagrs. $1.25. Recommended methods for testing the chemical and physical properties of dried or liquid adhesives made from rubber or from animal, vegetable, or synthetic materials. There is a short glossary of terms relating to adhesives.

MATHEMATICS

Applied Bessel Functions. F. E. Relton. London, Blackie and Son, Ltd., 1946. 191 pp., figs. 17*s.* 6*d.* Based on a series of lectures given at the Egyptian University, Cairo, this book is intended for those who have taken the mathematics that usually goes with a degree course in physics or engineering. No use is made of contour integration or of the complex variable in the analytic sense, but it is assumed that the student has a knowledge of ordinary differential equations with constant coefficients and some understanding of how partial differential equations are solved. In attacking the problem of establishing the existence and nature of the zeros of the Bessel functions, the author has chosen an unusual layout for the course, in which the recurrence formulas are made the starting point. A preliminary chapter on the ancillary functions is inserted to provide a groundwork for the study. There are chapters on cylindrical functions, Bessel's equation and the series solution, applications to oscillations, modified functions and their applications to dynamics and statics, applications to hydrodynamics and elasticity, Bessel coefficients, and allied functions. A note on the bibliographical aspects of the subject is included.

Theory of Functions. J. F. Ritt. Revised Ed. New York, King's Crown Press, 1947. 181 pp., figs. $3.00. The basic material for a two-semester course in the theory of functions given at Columbia University. Both the real and complex variable are covered, with emphasis on the latter. In treating the real number system, the author uses the method of infinite decimals, rather than the more profound systems of Dedekind or Cantor. All geometrical questions are formulated in arithmetical terms and every topological assumption made is explicitly stated.

NUCLEAR THEORY

Elementary Nuclear Theory. H. A. Bethe. New York, John Wiley & Sons, Inc., 1947. 147 pp., figs., tables. $2.50. Selected topics as given in a course of 20 lectures at the Research Laboratory of the General Electric Company. Emphasis is on nuclear forces, while theoretical considerations are brief. The text is divided into three parts: Descriptive Theory of Nuclei, Quantitative Theory of Nuclear Forces, and Topics Not Related to Nuclear Forces. A seventeen-page appendix of Table of Nuclear Species is included. The theory of the compound nucleus is treated only briefly. Understanding of higher mathematics and of the elements of the subject are essential for the reader. The author is Professor of Physics at Cornell University.

PHOTOGRAPHY

The Use of Aerial Survey in Forestry and Agriculture. J. W. B. Sisam. Gt. Brit., Imperial Agricultural Bureaux, Penglais, Aberystwyth, Joint Publication No. 9, 1947. 59 pp., 67 plates. 7*s.* 6*d.* A general outline of the economic and technical possibilities of aerial photography in making land-use and vegetational surveys. Factors affecting cost and efficiency and interpretation and application of photographs are treated on the basis of actual experience and previous surveys. The bibliography of 96 references pertains mostly to the applications of aerial photography.

PRODUCTION METHODS

Airplane Assembly Text Manual. Walter G. Shelton and Donald Wylan. East Saint Louis, Ill., Parks College of Aeronautical Technology, St. Louis University, 1947. 305 pp., illus. A manual for use in an aircraft-assembly course in conjunction with regular classroom lectures. The subject matter is grouped under headings that more or less correspond to the main assembly units and systems in the aircraft. The techniques used in forming, fitting, and joining of the various components are described, with emphasis on practical procedures. The Army, Navy, and S.A.E. specification-numbering systems for aircraft parts and materials are explained and illustrated by sample specification sheets. No particular aircraft has been used to illustrate the operations, and the material has been kept sufficiently general to apply to any type of airplane.

Assembly and Hydraulics: Project Book. East Saint Louis, Ill., Parks Air College, 1946. 70 pp., diagrs. An outline of the preliminary projects that are to be completed during the first 12 weeks of the course in airplane assembly. The initial projects familiarize the student mechanic with the use and function of the basic items of airplane hardware and fasteners. The sections that follow introduce the student to control cables and cable splicing; the cutting and mechanical joining of aluminum tubing; and the installation, rigging, and operation of brakes and shock-absorbing devices. The remaining portion of the text outlines the work in hydraulics to be covered in the second 6 weeks of the course. Fourteen projects treat of the pump, valve, cylinder, and locking units that are used in hydraulic control systems.

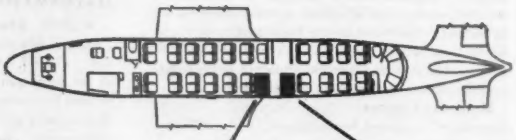
VIBRATION

The Simultaneous Determination of the Elastic and Shear Moduli with the Aid of the Modes of Bending Vibration of a Bar (Über die Gleichzeitige Bestimmung des Elastizitäts und Schubmoduls an Hand der Obertöne eines in Biegeschwingungen Stehenden Stabes). Jaakko Wuolijoki. (Doctorate Thesis Submitted to the Technische Hochschule of Finland.) Helsinki, Sanoma Oy, 1947. 79 pp., illus., diagrs., figs. (In German.) The equation of Timoshenko for the bending vibration of a rectangular parallelepiped is modified to obtain an accurate and an approximate frequency equation for a straight elastic bar having free bending vibration. All the quantities in the differential equation can be measured experimentally so that the modulus of elasticity and the shear modulus in terms of the frequency can be obtained. The equation can be solved by determining at least two of the modes of vibration and applying the method of least squares. A nomographic method of solution is given which may be substituted for the numerical method for practical cases where great accuracy is not required. In order to verify the accuracy of the equation and the method of solution, a test bar, suspended by two threads at the nodes of its fundamental mode of vibration, was subjected to forced vibration. The force was applied at one end of the bar by an electromagnet excited by current from an adjustable frequency alternator. The motion of the other end of the bar was observed in an oscilloscope. The first 15 harmonics ranging from 30 to 5,000 cycles per sec. were observed. The coefficients for the bar were also determined by static bending, tensile, and compression tests. The mean error of plus or minus 0.3 per cent for the elasticity modulus and plus or minus 0.5 per cent for the shear modulus was found. The English summary included in the text gives keyed references to the principal formulas, and definitions of the abbreviations and symbols employed. The bibliography contains 34 references, chiefly to German papers.

WORLD WAR II

The Blue Ghost; A Photographic Log and Personal Narrative of the Aircraft Carrier U.S.S. Lexington in Combat Operation. Edward Steichen. New York, Harcourt, Brace and Co., 1947. 151 pp., illus. $3.75. This book is based on the author's own experiences aboard the aircraft carrier Lexington during combat operations, including the period when she was under the longest sustained attack of the Navy's Pacific war. It contains 109 official U.S. Navy photographs.

How Airlines Solve SKY-HIGH Food Problems



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This Skygalley was designed and built for Trans-Canada Airlines' new DC4M2, the *North Star,* manufactured by Canadair, Ltd. The forward section, shown at left, contains: 4 meal boxes, septic drain tank, Monel sink deck and bowl, refuse can, cup dispenser, 2-gallon hot water tank, tray shelf, electric control panel, storage compartment, roll drawer, 2 silverware drawers Monel-lined.

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Sections and Branches

(*Continued from page 11*)

neered, constructed, and flown by June, 1946. However, by the time the first plane was sold to American Airlines, it was a completely redesigned aircraft that included air conditioning, cabin pressurization, underwing refueling, built-in loading ramps, etc., all of which did not appear in the original specifications drawn up in 1943.

▶ **Description**—The remainder of Fink's paper contained a description of the final model and the particular problems it entailed. One interesting development was the feature of the side loading main entrance which has an upward swinging door to counterbalance the downward swinging stairs, so that no power means is necessary for operation except a hand-operated lever.

The paper devotes considerable attention to development of the power plant.

Toronto Section

Carl V. Lindlow, *Secretary*

"Airworthiness" was the subject of a talk given by H. S. Rees, Chief Aeronautical Engineer of the Department of Transport at the October 15 meeting of the Toronto Section held at the University of Toronto.

▶ **Early Efforts**—Rees discussed the early efforts of the International Commission for Air Navigation and the need for rational requirements. Not only are rational requirements necessary to evaluate properly the airworthiness of advanced and unconventional designs, Rees said, but they usually have been found necessary before international agreements could be reached.

The speaker cited the Canadian Ski Requirements as an example of requirements based almost entirely on experience, which have yielded a satisfactory article in the past. The design torque on the ski is just suffiicent to allow one to attach a horse to the tail of the airplane to break the ski loose from the ice without damaging anything if the ski is not stuck too badly.

▶ **Canadian Ski Standards**—It was generally agreed at PICAO (at which Rees represented Canada on the Airworthiness Division), that Canada had more experience in this matter than any other country. Therefore, the Canadian Ski Requirements were accepted as recommended practice, pending the accumulation of more test data and a more rational approach to the problem.

With this in mind, Rees continued, tests are being conducted in Canada at the present time. He went on to discuss reasons why, at the present time, ultimate loads are one and a half times limit loads, and he gave some indication that this subject was being considered as well as requirements regarding use of high-strength aluminum alloys from the fatigue point of view.

▶ **CAR 04b Works Hardship**—During the discussion following Rees's talk, it was brought out that designing to requirements of CAR 04b works a great hardship on the small transport manufacturer insofar as the number of flight and landing cases to be investigated is concerned. Particularly laboricus, it was claimed, are the investigations required if the airplane is also to be equipped with floats and skis.

It was generally agreed among those present that some consideration should be given to abbreviating airworthiness requirements for such cases.

Chairman Ben Etkin announced that the next regular meeting of the Section, to be held November 19, would feature H. T. Dyment, Director of Engineering for Trans Canada Airlines, as speaker.

Wichita Section

Jerry H. Gerteis, *Secretary*

Lighter-than-air craft was the subject presented to the Wichita Section at its October 21 meeting.

▶ **South Atlantic Crossings**—Hal Dick, who formerly was with Goodyear Zeppelin Corporation and is a graduate of Massachusetts Institute of Technology, talked on "Some of the Design and Operating Problems of Lighter-than-Air Craft." Dick, who had been stationed in Germany for approximately 7 years as Goodyear's representative, has had considerable experience with both the design and operating phases of this type of aircraft. During his stay in Germany, he made many South Atlantic crossings.

A lengthy discussion period followed presentation of the paper during which members commented on the practicability of air ship travel on the commercial air lanes of the world.

Academy of Aeronautics

Two meetings were held in October by the Branch under chairmanship of Marvin Glenn.

In the October 7 session, the entire meeting was taken up with the showing of a film by The Glenn L. Martin Company entitled *PBM-3 Wing Destruction Test.* The film was a complete report on the procedure the Martin company undertook in order to determine the exact strain a wing from one of their aircraft could withstand.

At the October 21 meeting a short film on *Fuel Injection* was shown following a business session.

Aeronautical University

Two meetings of the Branch, on October 15 and 22, were devoted to discussion of, and voting upon, a new Constitution. The proposed Constitution, as reported in by the Constitution Committee, was orally voted upon Article by Article.

Charles White, Chairman, presided at the meeting of October 15, while the Vice-Chairman, E. R. Baker, Jr., presided October 22.

Alabama Polytechnic Institute

A talk on "The Boeing Wind Tunnel" was given at the Branch's October 14 meeting by K. G. Wells, Professor, Mechanical Drawing and Aeronautical Seminar. Professor Wells covered the historical background of the wind tunnel, its construction and operation.

At the October 29 meeting a film, *Planes Without Pilots,* was shown.

Polytechnic Institute of Brooklyn

"The History of the Institute of the Aeronautical Sciences" was the title of a talk by Dr. Nicholas J. Hoff, Professor of Aeronautical Engineering.

Dr. Hoff spoke in detail of the organization of the Institute, comparing it in part to the British Royal Aeronautical Society. He also mentioned two of the Institute's publications and pointed out their value to student engineers as well as to graduate engineers.

The showing of the film, *Tornado in a Box,* concluded the meeting. The film presented a brief historical account of the origin of the gas turbine, followed by a step-by-step development of the turbine from its early stages to the present.

Cal-Aero Technical Institute

For its opening meeting, held October 7, Institute's new branch members were briefed on the history of I.A.S. by Kenneth Mann, Faculty Sponsor, and were introduced to the newly elected officers. These included: Chairman, Jose Diaz; Vice-Chairman, Carl A. Tamarin; Secretary-Treasurer, Leonard R. Grignon.

Following the business session, G. H. Craig, Service Engineer, Consoli-

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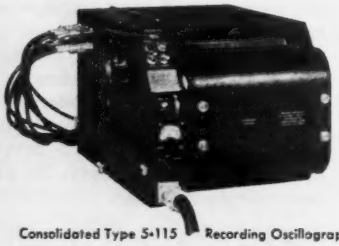

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dated Vultee Aircraft Corporation, gave a talk on the Convair B-36, opening with a statistical survey of the principal construction and flight characteristics of the bomber.

Carnegie Institute of Technology

At its first meeting of the new season, Carnegie Institute Branch members on October 21 elected the following officers: Chairman, Bernard Bace; Vice-Chairman, Francis Schierberl; Recording Secretary, H. Robert Jackson; and Treasurer, Edward Sweet.

At the second meeting, October 28, a business session was held, the Treasurer's report was given, and a Program Committee was appointed, headed by Francis Schierberl. A discussion followed on the possibility of making improvements in the Aeronautical Department of the school. R. I. Cross was appointed head of a committee of investigation.

University of Colorado

The meaning of the Institute of the Aeronautical Sciences and details of requirements for eligibility to membership were explained at the October 6 meeting of the Branch by Vice-Chairman Fred Kroll. A further explanation of the Student Branch was given by Prof. K. D. Wood, Head of the Aeronautical Engineering Department.

A film, *Wings Over Latin America*, was shown, concluding the meeting.

University of Detroit

Following a talk on the purposes and aims of the Institute, two films were shown at the October 2 meeting, presided over by Russell J. Cornair, Chairman. The films were *Tornado in a Box* and *Pilotless Aircraft* by Allis-Chalmers Manufacturing Company and Bell Aircraft Corporation, respectively.

Georgia School of Technology

Professor Alan Pope, Associate Professor of Aeronautics and author of the recently published book, *Wind Tunnel Testing*, gave a brief history of Georgia Tech's large wind tunnel at the Branch's October 7 meeting.

Conducting a tour of the tunnel, Professor Pope pointed out the Gunite construction, the 200-hp. electric motor, installation of the propeller, and the use of screening for turbulence control. Although it is a low-speed tunnel by present-day standards, Professor Pope said it was one of the most versatile of its type.

At the October 21 session, Capt. William E. McCullough, Assistant Professor of Military Science and Tactics, Military Department, Georgia School of Technology, gave a talk on "Early Jato Experiments." Early in the war, he had been assigned to the Jato project and worked with it throughout its development. He explained many of the problems encountered during experiments with both liquid and solid fuel auxiliary power units.

R. F. Woodal was elected to fill the vacancy created by Secretary Whitaker's resignation. Chairman Edmund E. Novotny presided.

University of Illinois

New members were briefed on the purposes, aims, and functions of the Student Branch of I.A.S. Several members of the faculty in the Department of Aeronautical Engineering, College of Engineering, explained the efforts of the Department in supplying aeronautical engineering students with a sound academic technical background.

Speakers of the evening were: Prof. Robert W. McCloy, Power Plants Section; Prof. Henry S. Stillwell, Head, Aeronautical Engineering Department; Jesse W. Stonecipher, Chief Flight Instructor, Institute of Aeronautics, University of Illinois; and Prof. H. H. Jordan, Dean (Associate), College of Engineering.

Indiana Technical College

An informal discussion of a field trip to Aeronca Aircraft Corporation at Middletown, Ohio, was conducted by Chairman Jack L. Bickhard at the October 7 meeting of the Branch. Construction details and assembly of an Aeronca plane were viewed by the group.

Following the discussion, plans were made for the next meeting.

Louisiana State University

At the first meeting of the year on October 7, the entire session was devoted to plans for a membership drive and for future meetings, which are to be held every two weeks.

Presiding officer was Arthur W. Cruikshank, Jr.

Mississippi State College

Election of officers took place at the October 2 meeting of the Branch, chairmanned by Robert E. Sizemore. The following officers were chosen: Chairman, Robert E. Sizemore; Vice-Chairman, Euell M. Vinson; Corresponding Secretary, Franklin H. Butler; and Treasurer, Rex Sells.

Two films, *Bell Helicopter* and *Construction of a Thunderbolt*, were shown.

New York University

Chairman Irvin G. Richlin, at the October 15 meeting, introduced members to the officers for the coming year. Honorary Chairman is Frederick K. Teichman; Chairman, Richlin; Vice-Chairman, Saul Ferdman; Treasurer, Sorrel Wildhorn; and Secretary, Melvin Brown.

The film, *PBM-3 Wing Destruction Test*, was shown.

University of Notre Dame

At the October 16 meeting, Joseph M. O'Hara, Chairman, presiding, members heard Stanley B. Smith, Project Engineer, Bendix Aviation Corporation, on the subject of "Trends in Aircraft Fuel Metering Problems."

On October 30, two films were shown: *Report on Jet Propulsion* and *The Lockheed P-80*.

E. J. Tursich reported that the first issue of *The Burble*, club paper, would be distributed November 3.

Ohio State University

With Treasurer Fred Tietzel presiding, the Branch's first meeting was held October 14. Two films were shown, *High Speed Refueling of Aircraft* and *Attitude Gyro*, following which E. L. Miller, Faculty Adviser and Honorary Chairman, gave a talk on last year's program and the prospects for the coming year.

Professor G. L. Von Eschen, Chairman of the Aeronautical Engineering Department, spoke about latest developments in the Department, including acquisition of a new building, much equipment, and prospects for more laboratory space. Also mentioned were the research projects in progress or in prospect in the Department.

Lieutenant Colonel Walker, Professor of Air Science and Tactics at O.S.U., described briefly the new program in the Air R.O.T.C. and how it tied in with the Aeronautical Engineering curriculum.

A paper sent by the Institute on Greater Safety in Personal Aircraft was read by Ralph Elmenthaler.

On October 28, an inspection tour of the Air Force experimental facilities at Wright Field was made by a group of 85 students and faculty members, sponsored jointly by the Branch and the Air R.O.T.C. unit.

University of Oklahoma

A business meeting was held October 2, presided over by Robert F. Faulkner, Chairman. New officers elected were: Chairman, Faulkner; Vice-Chairman, Owen G. Morris; Secretary-Treasurer, Leslie I. Hiatt; and St. Pat's Representative, Arch R. Gilchrist.

Parks College of Aeronautical Technology

Following proposals for two amendments to Branch By-Laws, the film, *Gliding Wings*, illustrating the history of gliding up to the outbreak of war, was shown. A second film, *High Speed Refueling of Aircraft*, demonstrating rapid refueling made possible by a Wayne Pump Company product, also was shown. Richard A. Dean, Chairman, presided.

The Pennsylvania State College

First meeting of the year on October 2 was opened with a welcome to incoming students by Dr. David J. Peery and Prof. S. K. Hoffman, Advisers. Branch officers were then introduced to members.

The film, *Report on Jet Propulsion*, tracing the history of jet propulsion, was shown. William Sunday, Chairman, presided.

At the October 23 meeting, Walter Brown, Jr., Associate Professor, Physics Research Laboratory, gave a lecture on the "Role of Electronics in Guided Missile Research." Professor Brown's lecture centered upon the importance of cooperation among engineers in perfecting guided missiles.

Rensselaer Polytechnic Institute

Following a business session, Acting Chairman Robert E. Bower presiding, a film, *PBM-3 Wing Destruction Test*, was shown at the October 9 meeting.

At the October 23 meeting, Vincent J. Schaefer, of General Electric Research Laboratory, spoke on "The Production of Snow and Rain in the Natural Atmosphere" to an audience of 150.

Spartan College

Featured speaker of the Branch's October 16 meeting was William Romine, Instructor, Spartan College of Aeronautical Engineering, on the subject of the "Employer's and Employee's Points of View."

Syracuse University

At the first meeting of the fall semester, October 24, Chairman Elton

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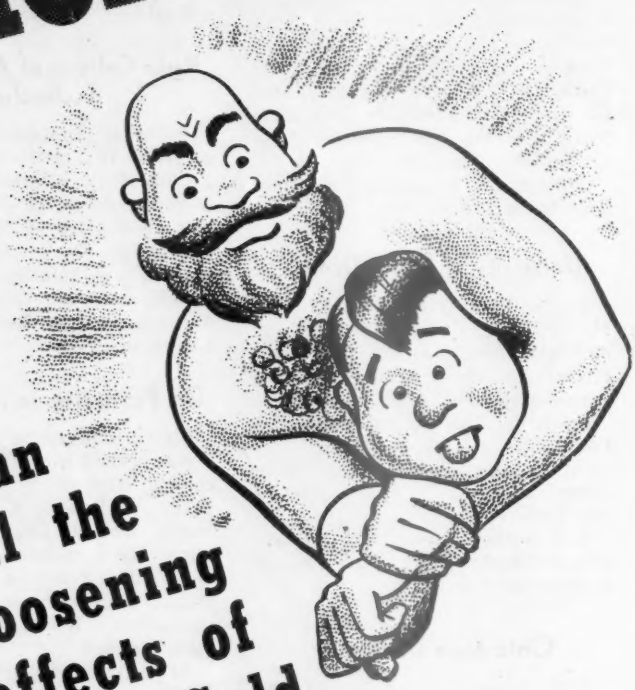

than all the loosening effects of Heat, Cold or Vibration

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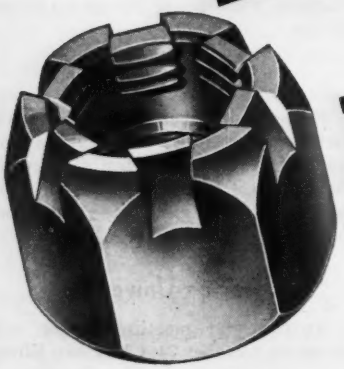

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Bischoff explained to new members the various committees and their functions and the benefits of I.A.S. membership.

Bruce Wills, student member, gave a talk on "Reduction of Pilot Error" by design of controls. A film, *Target: Berlin*, picturing the production of Avro Lancaster bombers in a Canadian factory, was shown.

Texas A. & M.

At an election held October 7, the following Branch officers were chosen: Chairman, William D. Menefee; Vice-Chairman, Robert L. Clinton; Secretary, Wayne H. Burch; and Treasurer, Robert C. Zivney. Thomas R. Salter was elected Junior Representative on the Engineering Council, and the Executive Committee was elected to serve as the Program Committee.

Following the elections, members discussed programs for future meetings.

Edward E. Brush, Head of the Aeronautical Engineering Department, announced that R. M. Pinkerton would be Faculty Sponsor for the Branch.

University of Toronto

A meeting was held September 9 to organize the U. of T. Student Branch under the chairmanship of Bernard Etkin (Faculty Sponsor).

Elections for officers resulted in the following: Chairman, C. F. Matthews; Vice-Chairman, C. J. Evans; Secretary-Treasurer, D. A. Ridler.

Tri-State College

During the October 1 meeting, Tri-State College Branch elected its officers for the current term as follows: Chairman, Clifton A. Smith; Vice-Chairman, Ray W. Wilson; Secretary-Treasurer, Dino H. Kintis; Senior Student Council Representative, Marshall L. Harshe; Junior Student Council Representative, John W. Keckler; and Student Reporter, Donald W. Ellison. New Honorary Chairman is Prof. S. M. Acton of the Aeronautical Department.

The second meeting, October 15, was devoted to business—two committees, the Constitution and By-Laws and the Project Investigating committees, were appointed. Heading the first is W. Austin, with W. H. Niesse and G. C. Hardwick. Project Committee is composed of L. J. Paszli, Chairman, W. H. Allen, and N. H. Klein.

The committees, respectively, are charged with the responsibility of revising the By-Laws to meet present requirements, subject to membership

approval, and the gathering of pertinent information regarding various opportunities for project work and presenting them to the members for consideration.

On October 29, the Student Council Representative reported on recreational opportunities and activities, and the Project Committee presented three ideas for consideration and action: wind-tunnel tests of conventional empennage assembly versus the Bellanca Bonanza tail assembly; tunnel tests of airfoils with extreme span-wise curvature; and study and investigation of helicopter flight.

University of Utah

A talk, "History and Purpose of the Institute of the Aeronautical Sciences," was given by Dr. Ralph D. Baker, Professor of Mechanical Engineering, at the October 2 meeting. Chairman Orsen L. Anderson presided.

A film, *Ground Controlled Approach*, was viewed, illustrating radar principles involved in bringing in aircraft in zero-zero visibility. The film was shown by courtesy of the Military Science & Tactics Department of the university.

At the October 16 meeting, Brent Creer was elected Corresponding Secretary to fill the vacancy caused by the resignation of Howard B. Smith. *Forces Acting on an Airfoil*, a film, was shown.

Virginia Polytechnic Institute

At its first meeting of the fall quarter, members elected a new Treasurer, Storrs G. Wright, to fill the vacancy made by the resignation of W. F. Seymour, III.

On October 21, a suggestion that all the engineering students be formed into an Engineers Club was voted on and passed. Two films, *The Fight for the Sky* and *Air Siege*, obtained from the Air Force, were shown.

Election of representatives to the newly formed Engineers Club was carried out at the November 6 meeting. In conclusion, the films, *Glider Bomb* and *Target for Today*, were shown.

University of Washington

First meeting of the Branch was held October 22, Chairman Raymond B. Oliver presiding. New officers elected included: Chairman, Howard Stine; Vice-Chairman, Harold K. Lockwood; Secretary-Treasurer, Boyce D. Cannon.

Following the business session, Girvis E. Ledbetter, University of Washington Research Associate, formerly with Curtiss-Wright Airplane Division Research Laboratory, was introduced by Robert H. Smith.

Ledbetter gave a talk on "The University of Washington's New Supersonic Wind Tunnel." In it he covered design features of the proposed tunnel and an analysis of supersonic wind-tunnel design in general.

News of Members

Andrew Anchutin, formerly Design Engineer with Jet Helicopter Corporation, has been named Design Engineer, Empennage Group Leader, Chase Aircraft Company, Inc.

Vincent Paul Arrigo is Planning and Scheduling Engineer, McDonnell Aircraft Corporation, having resigned from Curtiss-Wright Corporation, Columbus Plant, as Planning Engineer "A."

Charles Lee Baker, Jr., was named Chief Engineer, Trans-Texas Airways.

R. F. Barratt, formerly Aerological Officer with the Navy, now is the head of his own architectural firm.

Walter Bastedo, Jr., is Research Engineer, Grumman Aircraft Engineering Corporation.

Archibald Black is Design Engineer, Devenco, Inc., New York City.

Walter S. Bradfield resigned from The Johns Hopkins University to become Research Engineer, Aeronautical Research Center, University of Michigan.

William N. Brooks, Jr., former Navy Ensign, is Flight Aerodynamicist, Edo Corporation.

Bartram W. Bumsted was named Test Engineer, Reaction Motors, Inc.

Donald J. Colen, formerly a Design Engineer with United Aircraft Corporation, is President of Mardon Manufacturing Company, Inc.

Raymond J. Comenzo has been appointed Aeronautical Engineer, Langley Memorial Aeronautical Laboratory, N.A.C.A.

Dr. Robert A. Cornog was named Assistant Professor, Department of Mechanical Engineering, University of California.

George E. Cothren, Jr., is with Langley Memorial Aeronautical Laboratory, N.A.C.A., as Aeronautical Engineer.

Albert R. Crocker is now Research Engineer, Aerophysics Laboratory, North American Aviation, Inc.

Chadwick S. Dauwalter resigned from Lockheed Aircraft Corporation to become Associate Analytical Engineer, NEPA Division, Fairchild Engine & Airplane Corporation.

Harold W. Davis, former Project Engineer with Kellett Aircraft Corporation, is Assistant Chief Engineer, Backus-Stewart Company.

Maurice C. Davis is Junior Engineer, Bendix Aviation Corporation.

Jean de Chappedelaine, former Executive Assistant to Commanding Officer of Army Aviation Division, Netherlands Purchasing Commission, now is Technical Translator, International Civil Aviation Organization (Canada).

Robert E. DeLand is with Bendix Products Division, Bendix Aviation Corporation, as Stress Analyst. He resigned from The Glenn L. Martin Company as Senior Stress Analyst.

Hans R. Dettwyler was named Research Engineer in the Pilotless Aircraft Research Division, Rocket Propulsion Section, Langley Memorial Aeronautical Laboratory, N.A.C.A.

Carl H. Dolan resigned as Vice-President and General Manager of Allied Engineering Corporation, to become Professional Staff Assistant for Aeronautics, Consultant to U.S. Senate.

Daniel Otto Dommasch is Assistant Professor, Aeronautics Department, Iowa State College. He had been Project Engineer with Bell Aircraft Corporation.

James C. Dong is Senior Structures Engineer at Curtiss-Wright Corporation.

Robert Bell Douglas was named President, Godscroft Industries Ltd. (Canada).

Harry James Dunlop, former U.S. Army Captain, is Production Manager, L. N. Schwien Engineering Company.

Carroll W. Ellison, former Navy Ensign, is with Wright Aeronautical Corporation as Test Engineer.

Gustavus John Esselen, III, former Operations Engineer, Atlantic Division, Pan American Airways, is Development Engineer, Esselen Research Corporation.

Richard G. Fogg, former Lt. (j.g.), U.S.N.R., is Project Engineer, Aviation Gas Turbine Division, Westinghouse Electric Corportaion.

Irving Forsten resigned as Junior Project Engineer with Ranger Aircraft to become Graduate Assistant, New York University.

William Frantz is Project Engineer, Controls, Ranger Aircraft Engine Division, Fairchild Engine & Airplane Corporation.

Frank W. Furry, formerly with Bendix Aviation Corporation, was appointed Aerodynamicist in Aero Physics Laboratory, North American Aviation, Inc.

Samuel W. Gibson is Aeronautical Engineer P-1, Langley Memorial Aeronautical Laboratory, N.A.C.A.

Frank E. Goddard, Jr., is at M.I.T. as Aeronautical Staff Member. He resigned from The Glenn L. Martin Company.

Dr. James N. Goodier is Professor of Theoretical and Applied Mechanics, Stanford University.

Robin B. Gray, Navy Ensign, is Research Assistant, Georgia School of Technology.

William S. Haddock, Jr., resigned as Junior Layout Designer, Chance Vought Aircraft, is Instructor, Engineering, Drawing and Descriptive Geometry, Carnegie Institute of Technology.

Horace W. Hannah is Analytical Engineer, Engineering Department, Hamilton Standard Propellers Division, United Aircraft Corporation.

John W. Harrison, is Instructor, Department of Mathematics and Mechanics, University of Minnesota.

Bernhart H. Hasselbring resigned from Engineering & Research Corporation to become President, Engineering & Development Company.

Edward D. Heller is Design Engineer, Consolidated Vultee Aircraft Corporation.

Irving D. Hirschfield, A.A.F. veteran, is President, Pacific Electronic Products Company.

Richard Hittner resigned from his War Department post at Mitchel Field to become Engineering Draftsman, The Norden Laboratories Corporation.

Glen D. Hollinshead, Graduate Student in Aeronautics, H. H. Rackam School of Graduate Studies, Ann Arbor, is Aerodynamics Engineer, Hamilton Standard Propellers Division of United Aircraft Corporation.

George W. Jeffs, Navy veteran, is Aerodynamicist B, North American Aviation, Inc.

James B. Jones, formerly Chief Mechanical Engineer, Deering Milliken Research Trust, is Consultant.

Geves George Kenny is Principal, G. G. Kenny & Associates.

Carl Fred Koenig, III, resigned from Westinghouse Electric's Gas Turbine Division, is Development Engineer, De-Laval Steam Turbine Company.

Samuel Kraus is engaged in Graduate Study in the Department of Aeronautical Engineering, Rensselaer Polytechnic Institute.

August R. Krenkel resigned from McDonnell Aircraft Corporation to become Research Assistant, Gas Turbine Laboratory, M.I.T.

Philip Krop is Teaching Fellow, Virginia Polytechnic Institute.

Marcus Langley is Director, Tiltman Langley Laboratories, Ltd., England.

William M. Lee, Navy Ensign, is with Northrop Aircraft, Inc., as Aerodynamicist.

Herman M. Liess is Aeronautical Engineer, N.A.C.A.

Stanley H. Lowy, former Member of the Staff of Oregon State College, is Instructor, Mechanical Engineering, Oregon State.

Howard Nelson Lynch is Aeronautical Engineer, Piasecki Helicopter Corporation.

Carl J. Martin, formerly with BuAer, Navy Department, Washington, D.C., is Flight Analyst—Aeronautical Engineer, C.A.A.

James W. McGinness resigned from National Airlines to become Mechanic, Northern Airlines, Inc.

William G. McLoughlin is Associate Engineer, Applied Physics Laboratory, The Johns Hopkins University.

Kenneth F. Merten was appointed Aeronautical Engineer, Langley Memorial Aeronautical Laboratory, N.A.C.A.

Frank C. Mills, Jr., formerly Aerodynamicist "B," Douglas Aircraft Company, Inc., is now Assistant Professor of Mechanical Engineering, Clemson Agricultural College.

Bartive Minassian resigned from Boeing Aircraft Company to become Engineer, Northrop-Hendy Company.

Walter S. Misener, former R.C.A.F. Pilot Officer, resigned as Aerodynamicist, Gas Turbine Division, A. V. Roe Canada Ltd., to become Graduate Teaching Assistant, Purdue University.

William J. Mleczko is connected with the Pilotless Aircraft Research Development Group, Langley Memorial Aeronautical Laboratory, N.A.C.A.

Antony J. A. Morgan is Research Assistant and Graduate Student, California Institute of Technology (Aeronautics Department).

F. E. Newbold, Jr., formerly Assistant Manager of Engineering Operations, Ranger Aircraft, Engine Division, Fairchild Engine & Airplane Corporation, has been appointed Manager of Engineering Operations.

Clinton T. Newby is Engineer, G. Bruce Newby.

Leo Newman is Assistant Group Engineer, Republic Aviation Corporation.

John B. Nichols, Navy Ensign, is Aerodynamicist, General Electric Company.

Byron Nierenberg resigned from Republic Aviation Corporation to become Design Engineer, Nathan Aircraft Devices Company.

John Noyes, Jr., is Design Engineer, Geo. E. Wells, Inc.

James E. O'Neill, Navy j.g., is Research Assistant, Division of Industrial Cooperation, Massachusetts Institute of Technology.

Arthur N. Paul, former Instructor at Purdue, is Assistant Professor of Mechanical Engineering, University of Kansas.

Jerome Persh is Aeronautical Engineer (Research), Langley Memorial Aeronautical Laboratory, N.A.C.A.

Thomas R. Pierpoint is Service Manager, Piasecki Helicopter Corporation.

Joseph J. Quartana is with E. I. du Pont de Nemours & Company as Junior Engineer (Construction).

Joseph A. Ready is Research Aerodynamicist, Cornell Aeronautical Laboratory.

Dr. James F. Reagan is Head, Department of Aeronautical Engineering, Parks College, St. Louis University.

Richard P. Reul is Assistant Project Engineer, Radioplane Company.

Arthur E. Rowland has been named Acting Head, Department of Aeronautical Engineering, Virginia Polytechnic Institute.

Joseph Rubin is with Pan American Airways as Aeronautical Engineer.

Alvin H. Sacks, Aeronautical Research Scientist P-3 N.A.C.A., is on leave of absence doing graduate work in Aeronautical Engineering at Cornell University.

Alexander Satin formerly with Avion, Inc., is Structures Engineer "A," Northrop Aircraft, Inc.

James Walter Schmitt is Draftsman, M. W. Kellogg Company.

Robert C. Sellers is Aviation Technical Adviser, Royal-Liverpool Group.

Luis Alfredo Sepulveda is with Chilean National Air Lines as Aeronautical Engineer.

George S. Sexton was named Aerodynamics Engineer, Chance Vought Aircraft Division, United Aircraft Corporation.

John F. Shea is Design Engineer, Imagineering Associates, Inc.

George L. Stevens, formerly with Kennecott Copper Corporation, is Aeronautical Engineer P-1, Langley Memorial Aeronautical Laboratory, N.A.C.A.

George I. Toumanoff is Senior Research Engineer, Republic Aviation Corporation.

Ray G. Trout is Design Engineer, Piasecki Helicopter Corporation.

Robert S. Volin was named Tester—Power Plant Components, Ranger Aircraft Engine Division, Fairchild Engine & Airplane Corporation.

Wayne R. Wadington is Engineer, Fairchild Aircraft Division, Fairchild Engine & Airplane Corporation.

Kenneth G. Wells, former Model Design Engineer, is with Alabama Polytechnic Institute as Assistant Professor of Engineering.

Dr. David T. Williams resigned from University of Michigan to become Division Supervisor, Battelle Memorial Institute.

Warren G. Yoder was appointed Instructor, University of British Columbia (Canada).

Charles M. Zimney, Graduate of Purdue, is Aeronautical Engineer, Aircraft Engine Research Laboratory, N.A.C.A.

Members Elected

The following applicants for membership or applicants for change of previous grades have been admitted since the publication of the list in the last issue of the REVIEW.

Elected to Associate Fellow Grade

Echols, Oliver P., President, Aircraft Industries Association of America, Inc.

Jackman, Kenneth Ransom, B.S. in Ae.E. & M.E., Chief Test Engineer in Charge of Engineering Test Labs, Consolidated Vultee Aircraft Corp.

Elected to MEMBER Grade

Bortner, William Albert, Sr. Project Engineer, The Glenn L. Martin Co.

Foshag, Frederick Carl, B. of Engineering, Sr. Mech. Engineer, Test Equipment Engineering Dept., Aircraft Engineer Div., Packard Motor Car Co.

Hotson, Frederick William, Ae.E., Pilot-Engineer, Lome Airways.

Jenks, Frederick Perry, Ph.D., Group Engineer—Research, Lockheed Aircraft Corp.

Roy, J. Albert, B.S., Supervisor, Experimental Structures Section, Naval Air Experimental Station, U.S. Naval Base Station (Philadelphia).

Slonim, Jack Arthur, Ae.E., General Manager, Pilotless Plane Div., Fairchild Engine & Airplane Corp.

Vavra, Michael Hans, M.E., Assoc. Professor, Aeronautical Dept., U.S. Naval Postgraduate School, U.S. Navy.

Warner, DeVar Knowlton, Supervisor of Flight Test Instrumentation, North American Aviation, Inc.

Transferred to MEMBER Grade

Blake, Charles Little, M.S. in Ae.E., Aerodynamic Engineer, Wind Tunnels, Consolidated Vultee Aircraft Corp.

McLellan, Charles Herbert, B.S. in Ae.E., Aero. Engineer, Aero. Research Group, Langley Mem. Aero. Lab., N.A.C.A.

Tseu, Payson Sung, M.S. in Ae.E., Asst. Aerodynamic Project Engineer, North American Aviation, Inc.

Elected to Associate Member Grade

Bourke, Patrick, Inspector 1/C Aircraft Overhaul, Aer Lingus (Irish Air Lines).

Fitzpatrick, James L. G., M.Sc., Proprietor, Fitzpatrick Co.—Chairman, Machine Construction Dept., Straubenmueller Textile High School.

Gibson, Russell Lang, President & Managing Director, Cub Aircraft Corp. Limited (Canada.)

Seagrist, Eldon John, B.S., Instructor in Ae.E., University of Illinois.

Sheker, Clifford George, B.S., Engineering Instructor, Math. & Aircraft Structures, Aeronautical University, Inc.

Transferred to Associate Member Grade

Pierce, Hugh Otis, Flight Engineer, Flying Tiger Lines.

Elected to Technical Member Grade

Culen, Frank Anthony, Ae.E., Aerodynamicist, Jensen Helicopter Co., Inc.

Davidson, Theron Wesley, B.S.M.E. (Aero), Aero. Engineer P-2 (Coordinator), Instrument Section, Tactical Test Div., N.A.T.C. (Patuxent River, Md.).

Fuqua, Robert Patterson, B.S., Engineering Instructor, Aeronautical University, Inc.

Squires, Arthur Douglas, Draftsman, Dept. of Design & Engineering, A. V. Roe (Canada) Ltd.

Sumrall, Calhoun W., B.S., Aerodynamicist, Northrop Aircraft, Inc.

Transferred from Student to Technical Member

Bryant, Robert Lee, Ae.E., Engineer (Aero.), Grumman Aircraft Engineering Corp.

Bursnall, William Jesse, S.B., Aero. Engineer P-1, Langley Mem. Aero. Lab., N.A.C.A.

Derdiarian, Kachas, Ae.E., Sr. Draftsman, Pan American Airways, Inc.

Drake, Willis K., B.S. in Ae.E., Asst. Engineer, Engineering Services Div., Engineering Research Associates, Inc.

Edwards, John Pierce, B.S. in M.E., Apprentice Engineer, Grumman Aircraft Engineering Corp.

Gentle, Paul Thomas, B.S. in Maintenance Engineering, Sr. Detailer, McDonnell Aircraft Corp.

Hoeflein, Robert Walter, B.S. in Ae.E., Engineer, Aero Products.

Kipin, George, B.S. in Ae E.

Lively, Edith Hall, Miss, B.A.A.

Lopatoff, Mitchell, B.S. in Ae.E., Aero. Engineer, Langley Mem. Aero. Lab., N.A.C.A.

Loughridge, Raymond Haynes, B.S. in M.E. (Aero. Option), Engineer, Aluminum Steel Company.

Marhefka, Robert Joseph, C.E., Sr. Detail Draftsman, McDonnell Aircraft Corp.

McDavit, John W., Jr., Assistant-Production Control, Chase Aircraft Co.

Meyer, Donald Joseph, B.S. in Ae.E., Draftsman, McDonnell Aircraft Corp.

Moyer, John C.

Oldenburg, Richard Leon, Test Engineer, Grumman Aircraft Engineering Corp.

Paupy, Roberto Fernandez, M.Sc. in Ae.E., Lt., Argentine Navy Air Force.

Skawienski, Theodore L., B.S.

Wade, Merwin Gerald, B.S. in Ae.E., Graduate Assistant, Purdue University.

I.A.S. National Meeting Schedule

Sixteenth Annual Meeting—Hotel Astor, New York—January 26–29

Flight Propulsion Meeting—Hotel Carter, Cleveland—March 26

Members or organizations wishing to submit papers for presentation at National Meetings should send outlines or summaries to the Committee at least 3 months prior to the meeting.

All papers submitted will be considered for publication in the *Journal of the Aeronautical Sciences* or the *Aeronautical Engineering Review.*

All correspondence should be addressed to The Meetings Committee, Institute of the Aeronautical Sciences, 2 East 64th Street, New York 21, N.Y.

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The Institute of the Aeronautical Sciences has received many requests from its members and subscribers for lists of individuals and organizations offering specialized professional services. To provide a directory listing services of this type, a special section "PROFESSIONAL CALLING CARDS" has been inaugurated.

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Personnel Opportunities

This section is for the use of individual members of the Institute seeking new connections and organizations offering employment to aeronautical specialists. Any member or organization may have requirements listed without charge by writing to the Secretary of the Institute.

WANTED

Assistant Professor or Instructor—Staff member to teach aircraft structural analysis and applied mechanics; also to set up complete structural testing laboratory. Must be familiar with aircraft structural practices in order to work with local aircraft industry. Previous teaching experience desired but not essential. Please give brief sketch of education, experience, and personal qualifications. Address, Kenneth Razak, Head of Aeronautical Engineering Department, University of Wichita, Wichita, Kan.

Mechanical Engineer—An excellent opportunity is open for a mechanical engineer with experience in gas turbines. You will have the best of laboratory equipment to work with and an opportunity for freedom of expression and development of ideas with the leading manufacturer of automatic control equipment. Write today giving full particulars of your training and experience: J. A. Johnson, Minneapolis-Honeywell Regulator Company, 4th Ave. and 28th St., Minneapolis 8, Minn.

Flutter Engineer—Aeronautical Engineering graduate with several years of experience in flutter and vibration problems for work on advanced military aircraft. Address reply to Engineering Personnel Office, North American Aviation, Inc., Municipal Airport, Los Angeles, Calif.

Aerodynamicists and Aeronautical Engineers—Positions available for highly qualified technical personnel with good theoretical or experimental background to engage in development and model test work in stability, control, high-speed, and supersonic aerodynamics. Projects include new models of piloted and pilotless aircraft, new wind tunnels and associated equipment, and advanced testing techniques. Salary in accordance with qualifications and Civil Service regulations. In reply, please give brief summary of personal qualifications, education, and experience. Address—Director, David Taylor Model Basin, Washington 7, D.C.

Instructor or Professor—To take charge of, and to teach, subjects in the aeronautical option of mechanical engineering department. Subjects consist of aerodynamics, airplane design, internal combustion engines, etc. Complete laboratory equipment, including B-17 Flying Fortress, P-51 Fighter, Link trainers, and wind tunnel. Rank and salary dependent on qualifications. Teaching experience not necessary. Applicants should write to the Department of Mechanical Engineering, Montana State College, Bozeman, Mont.

Jet Power Plant Specialists, Theoretical Aerodynamicists—Experienced men needed for development work on subsonic and supersonic guided missiles. Write to or apply at Marquardt Aircraft Company, 4221 So. Lincoln Blvd., Venice, Calif.

Engineers—Long-term helicopter development program for Army Air Forces requires additional engineering personnel: (1) stress engineers with 4 or more years' experience, (2) senior layout men, and (3) mechanical draftsmen. Apply in writing to Manager, Helicopter Division, Kellett Aircraft Corporation, North Wales, Pa.

The U.S. Naval Air Station, Pensacola, Fla., is accepting applications of highly qualified and experienced personnel for various positions as follows: **Industrial Engineer,** P-6 at $7,102.20 per annum, P-3 at $4,149.60 per annum; **Organization and Methods Examiner,** CAF-9 at $4,149.60; **Methods Examiner—Forms,** CAF-7 at $3,397.20 per annum; **Engineer Draftsman—General,** SP-6 at $2,644.80 per annum; **Statistical Draftsman,** CAF-5 at $2,644.80 per annum. Applicants may obtain Civil Service Application Form 57 from their local post office. Forward applications, completely filled out, to the Recorder, Board of U.S. Civil Service Examiners, U.S. Naval Air Station, Pensacola, Fla.

Professors and Instructors in Aeronautical Engineering—With the changed Aeronautical Engineering course from 4 to 5 years and extended graduate study facilities, the University of Minnesota, Department of Aeronautical Engineering, has positions available for a full professor in aeronautical engineering with industrial experience; assistant professor in modern theoretical and applied aerodynamics; and two instructors in the field of general aeronautics. Applicants must have Aeronautical Engineering degree and M.S. degree for higher positions. Extra compensation for summer work and opportunities for part-time research. Address: Department of Aeronautical Engineering, University of Minnesota, Minneapolis, Minn.

Assistant Professor—To teach courses in aircraft structures. The primary duties of the position will be concerned with aircraft structures, but the applicant should possess enough knowledge of aerodynamics to permit him to assist occasionally in elementary aerodynamic courses. Prefer a man with teaching and practical experience. In applying, please give brief sketch of personal qualifications, education, and experience. Address: Acting Dean R. P. Davis, College of Engineering, West Virginia University, Morgantown, W. Va.

Aircraft Dynamics Engineers—For research work on subsonic and supersonic flutter, vibration, dynamic loads, stability and control of supersonic missiles, and helicopter dynamic problems. Applicants must have good background in fundamentals in applied mechanics and mathematics. Advanced degree or previous experience in field is essential. Salaries commensurate with training and experience. Cornell Aeronautical Laboratory, Employment Office, 4455 Genesee St., Buffalo 21, N.Y.

Servomechanism Engineers—Experienced in analysis, design, or testing of electrical or hydraulic servomechanisms or powered flight controls. Strong knowledge of stability analysis and test methods desired. Salary commensurate with training and experience. Inquire Personnel Manager, Boeing Aircraft Company, Seattle 14, Wash.

Structures Engineers and Stress Analysts—Experienced in aircraft structures and stress analysis. Three to 10 years' or more experience desired. Salary commensurate with training and experience. Inquire Personnel Manager, Boeing Aircraft Company, Seattle 14, Wash.

The number preceding the notices represents the Box Number of the Institute of the Aeronautical Sciences to which inquiries should be addressed.

Hydraulic Engineers—Experienced in design and analysis of aircraft hydraulic mechanisms and components. Salary commensurate with training and experience. Inquire Personnel Manager, Boeing Aircraft Company, Seattle 14, Wash.

Mechanical Design Engineers—Experienced in design of light high-speed rotating machines. Also experienced in light and medium aircraft-engine and engine accessory design. Salary commensurate with training and experience. Inquire Personnel Manager, Boeing Aircraft Company, Seattle 14, Wash.

Stress Analysts—Personnel with experience on sheet metal, monocoque, cargo-type aircraft desired. Graduate engineers with 5 or more years' experience preferred. All replies held confidential. Write, Project Engineer, Chase Aircraft Company, Inc., West Trenton, N.J.

Chief Aerodynamicist—Services of highly qualified person to act as chief aerodynamicist. All applicants must be graduate engineers of recognized universities. Experience on cargo or large type of aircraft desirable. Applicants should write, giving complete details of education and experience, list references and salary expected, as well as availability. All replies held confidential. Write, Project Engineer, Chase Aircraft Company, Inc., West Trenton, N.J.

Assistant Professor—Assistant Professor of Aeronautical Engineering wanted to teach junior and senior courses at Oregon State College. A man with graduate degree, teaching and industrial experience preferred. Address replies to B. F. Ruffner, Oregon State College, Corvallis, Ore.

812. Engineer—Production—Trained in designing for low-cost production. Must be a graduate engineer and have aircraft experience. Progressive and expanding concern in metropolitan Philadelphia area. Send complete résumé.

811. Engineer, Mechanical—Experienced in the designing of precision transmission systems. Aircraft experience preferred. Progressive and expanding concern in metropolitan Philadelphia area. Send complete résumé.

810. Engineer—Qualified aeronautical or mechanical engineer with a minimum of 4 years' experience in the helicopter field. Progressive and expanding concern in metropolitan Philadelphia area. Send complete résumé.

804. Theoretical Aerodynamicist—A Ph.D. in Aeronautical Engineering, Mathematics, or Physics is needed at a large Mid-Western university as an associate professor or professor in the Department of Aeronautical Engineering to teach advanced theoretical courses in aerodynamics. The duties would include advanced undergraduate and graduate teaching through the Ph.D. level and the direction of theses. Opportunities for research, research consultation, and industrial consultation exist.

800. Assistant Professor—Dynamics—A leading state university with recognized department of aeronautical engineering and both undergraduate and graduate divisions needs permanent staff member to give courses in vibrations, flutter, and the dynamics of the airplane and to direct graduate research in this field. Position is permanent. Rank—Assistant Professor or higher.

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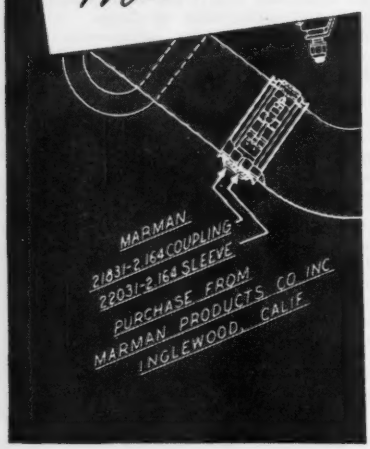

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799. Associate or Professor—Middle West state university with strong graduate division in aeronautical engineering needs additional new permanent staff member to develop and give instruction in the general field of supersonic aerodynamics and to direct basic and applied research in this field. Rank—Associate Professor or higher. Salary attractive. Starting date February, 1948, but can wait until September, 1948, if necessary.

798. Airplane Flight-Test Engineers—Aerodynamicists with experience in stability and control work and flight testing. Position requires a good academic background and sound knowledge of dynamics and applied mathematics. Advanced degree desirable. Must have training, experience, and ability to assume major responsibility in both the theoretical and experimental flight-test phases of major programs of aircraft flight dynamics and be familiar with standard methods of flight-test data reduction.

796. Chief Stressman—With C.A.A. requirements experience, and one or two assistants, to take charge new project. Reply stating full particulars of past experience, salary required, and when free to take up a new position.

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815. Aeronautical Engineer—B.S. in Ae.E., Iowa State College. Age 22. Single. Two years' practical experimental test and development engineering experience with prominent aircraft-engine manufacturer involving fuel control and engine performance. Sound theoretical training in aerodynamics and structures. Desires varied experience and improved opportunities. Location unimportant. Available within 30 days.

814. Aeronautical Engineer—Age 36; married. Two and one-half years with major aircraft manufacturers as a specialist in weights and balance, technical writing, technical reports, and specifications writing. Able to handle and familiar with machine-shop practice. Holds a valid A. & E. license from the C.A.A. Has had approximately 12 years' all-around experience on transport and private type aircraft as a technician. Would like position as technical reports writer, liaison, and/or maintenance engineer.

813. Flight Engineer—Age 29. Seven years' air-line experience. Five years' flying with approximately 4,000 hours on B-314, PB-2Y, C-87, C-54, DC-4, L-49, L-749. A. & E license, Flight Engineer's license, B.M.E. degree. Interested in settling on West Coast with air line that has an expanding flight engineering department.

809. Aeronautical Engineer—Age 31; married. Graduate engineer in South America; B.S. Ae.E. in this country; also maintenance engineer in U.S.A.F. technical school. Ten years' experience in aviation maintenance, overhaul, and purchasing. Purchasing engineer for a South American air force and air line for 2 years. At present working own export business. Desires position with manufacturer, air line, or aviation maintenance company, either in this country or in South America. Will furnish details and references on request.

808. Design Engineer—Graduate, pilot. Extensive private airplane design experience directing project, structures, flight-test groups. Desires position utilizing background.

807. Project Engineer—Ph.D. Extensive experience in industrial research in supersonic aerodynamics and guided missiles. Fifteen years' university teaching and research. Interested in developing fuel and propulsion research program, either university or industrial. Presently employed by West Coast airplane company. Available immediately.

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805. Engineer—Englishman; age 29; married. Just resident in Canada. Seven years' administration, air-line maintenance, overhaul, planning, technical authorship (one published). Good contacts in British civil aviation. Will consider any progressive post.

803. Aeronautical Engineer—B.S. in Aeronautical Engineering. Age 25, married. Two and one-half years' experience as structural engineer in personal aircraft field. Thoroughly familiar with C.A.A. procedures under both C.A.R. 04 and 03. Also has good practical background in radio, radar, and electronics. Holds Commercial Radiotelephone Operator's License. Desires position associated with design and development of aircraft electronic equipment or in personal aircraft field. Prefers West Coast or east of Mississippi.

802. Technical Translations—From English to French, or conversely, by French aeronautical engineer. At present technical translator with an official aviation organization. Twenty-five years in the aeronautical field and well known for his research and realizations in France and in U.S.A.

801. Law-Engineering—B.Ae.E. degree and completing L.L.B. degree. Six years' experience in testing of experimental aircraft and missiles, static, dynamic, and flight tests, for a Government agency. One and one-half years' part-time patent law experience. Former officer of local I.A.S. Section. Good appearance, personality, and excellent in personnel relations. Desires position combining engineering and law with a law firm, engineering company, aero-insurance company, etc., in contract, patent, or similar work. Los Angeles, New York, or Philadelphia areas preferred.

797. Dynamics, Vibration, and Flutter Specialist—Thirteen years' academic and industrial experience in this field. Holding considerable unpublicized knowledge for employer desiring high caliber services. Supervisory rank not mandatory, but equivalent salary. Please describe opening.

795. Aeronautical Engineer-Pilot—B.S. in Ae.E. from University of Michigan. Age 32; married. Two years in present position designing major units for leading aircraft manufacturer. Familiar with Army, Navy, and C.A.A. requirements. Naval aviator for 7 years. Two thousand four hundred hours' flight time. Two years' experience supervising 25 mechanics and maintenance of 20 dive bombers aboard an aircraft carrier. Seven months as an executive officer. At present, commanding officer of an air group and fighter squadron in the Organized Naval Reserve, with former rank of Lieutenant Commander. Holds C.A.A. commercial single and multiengined land and instrument ratings. Desires position combining flying and engineering or flying and administrative-executive work.

794. Engineer—M.E., M.M.E., Ph.D.; age 42. Associate Professor teaching applied mechanics and fluid mechanics. Some industrial research experience in stress analysis and mechanical design. Broad general background in mechanical and aeronautical engineering. Desires position in industrial research and development or as head of department teaching applied mechanics.

793. Graduate Aeronautical Engineer—Eight years' layout and design experience. Twenty-six months' service as aeronautical engineer, Naval Aircraft Factory. Also college instructor in engineering drawing for two terms. Desires position in supersonic or guided missile research or rotary-wing field.

792. Electronics Engineer—Age 26; B.S.E.E., 1943, and graduate study for the degree M.S.E.E. Three years' Army radar experience and 1½ years' experience with an Eastern aircraft concern as an electronics engineer. Has been associated with development of radio-controlled aircraft and missiles, automatic pilot development, flight-test instrumentation and servomechanisms. Presently employed, but intends to leave the East and desires new connections, preferably in Southern California.

790. Aeronautical Engineer—B.S. in Aeronautical Engineering; age 29. Four years' experience as Army Air Force Maintenance and Supply Officer, B-26, B-24, and B-29. Desires position as maintenance supervisor for foreign or domestic air line. Also interested in position as sales and service representative for an export organization of aircraft, engines, and aircraft component parts. Details and references upon request.

787. Engineering Test Pilot—Age 29, married. Continuously employed during the past 6 years by four major aircraft manufacturers as experimental or engineering test pilot; jet and reciprocal power fighters, dive bombers, seaplanes, and helicopters. Actual stability, preliminary and final demonstration experience on Army, Navy and C.A.A. programs. Available within 30 days.

786. Aeronautical Engineer—B. of A.E. and A.E. degrees. Age 25, married. Experience: design and development of aeronautical and mechanical components; stress analyst; liaison engineer; processing. Desires position in above or related fields.

783. Engineer—Age 32, B.M.E., M. Aero. E., with 7 years' varied experience in analysis and research on commercial and military aircraft structures, guided missiles and power plants, including gas turbines; emphasis on stress analysis, thermodynamics, and fluid flow.

782. Power-Plant Engineer—Eight years' experience in gas-turbine power plants for aircraft and industrial applications. In charge of installation, service, and sales departments. Well versed in the organization and administration of sales and service sections. Has overseas experience in the service and sales field, plus technical advisory experience to foreign manufacturers.

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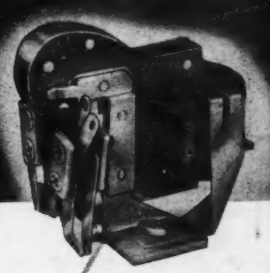

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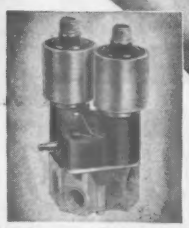

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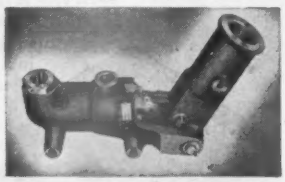

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781. Power-Plant Development Engineer—Age 31; married; B.S. in Aeronautical Engineering, University of Michigan. Three years as test engineer on research and development of large aircraft-engine superchargers. Three years' experience on development of aircraft gas turbine. In direct charge of development of automatic high-speed air valves. One year as supervisor on large altitude chamber with adequate facilities for testing power plants at 100 per cent altitude conditions. Thorough training in fluid mechanics, thermodynamics, and airflow instrumentation. State registered.

779. Aeronautical Engineer—B.Ae.S. degree, University of Minnesota, 1940. Age 31, married. Six years' experience with prominent aircraft propeller manufacturer involving drafting, weight control, aerodynamics, plus extensive experience in installation engineering pertaining to aircraft propellers. Held supervisory position in Installations Department at time of resignation to form own airport operations organization. Location open.

777. High School Aeronautics Teacher—Age 29, married. Author of three technical books on aviation education, aircraft operations, aviation course of instruction for high schools and colleges. Twelve years' practical experience in operational aviation, all phases. Seven years' aviation teaching experience. Teaching aeronautics in a Southern high school at present. Would like better position teaching basic or primary aerodynamics and/or structures in a college offering aeronautical engineering or aeronautical courses.

776. Sales Engineer—B. in A.E., Rensselaer Polytechnic Institute; age 26, married. Four and one-half years' research experience plus 20 months spare-time study (International Correspondence Schools) of corporate organization and finance, business law, accounting, and marketing. Private pilot. Desires sales engineering connection in industry where the combination of sales ability with a sound engineering background will be valuable. Location open. Salary incidental to advancement opportunities.

775. Aeronautical Engineer—B.S. in Aeronautical Engineering. Age 28, single. Thirty-two months' experience, 17 months in design layout, 15 months in flight testing. Desires position in Eastern United States in flight testing or research. Will consider design layout.

774. Engineer—Age 26, married. B.Ae.E., N.Y.U., 1944. One year of graduate work at N.Y.U. including courses in compressible flow, gas turbines, structural analysis, and advanced mathematics. Two years' experience in maintenance and inspection of A.A.F. transport aircraft as engineering officer both in U.S. and Pacific Theater. Location open.

773. Pilot—Engineer—B.S.Ae.E. from Purdue University. Age 25, single. Presently holds valid commercial pilot's license with single- and multi-engined, instrument, and instructor ratings. Acquired extensive experience as B-29 flight engineer during war. Leaving present position as flight supervisor at large Midwestern university airport. Interested in sales engineering, pilot for private concern, or flight-test work. Will locate anywhere but prefers East Coast.

771. Mathematician — Engineer — Age 33; B.S., M.A., 60 graduate credits in mathematics; 4 years' evening mechanical engineering course. Six years' experience teaching mathematics; 2 years' experience in aerodynamics, including transonic and supersonic aircraft and missiles; 1 year as research engineer on auto pilot and hydraulic shock absorbers; 2 years' administrative experience as manager of service department with manufacturer of aircraft hydraulic pumps and landing gears. New York, New Jersey, or Long Island area preferred.

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Celebrate 15th Anniversary at Summer Meeting Dinner	*Aug.*	5
Chapline Appointed General Manager of Ranger Aircraft	*Mar.*	12
Davidson Appointed to Policy Board of Applied Mechanics Reviews	*Mar.*	12
Davidson Awarded Wetherill Medal by Stevens Institute	*Apr.*	6
Admiral de Florez Honored by Naval Order	*Jan.*	9
Director's Report	*Mar.*	9
Dryden Succeeds Lewis in N.A.C.A. Post	*Oct.*	6
Donnell W. Dutton Appointed Scientific Research Adviser	*Jan.*	9
Early Birds Re-Elect I.A.S. Members	*Nov.*	7
Fairbanks General Manager of S. Fairchild and Associates	*July*	7
Fairchild Forms Association of Technical Consultants	*Apr.*	6
Fairchild Publication Fund Expanded	*Aug.*	7
First Anglo-American Conference	*Oct.*	12
First I.A.S.-R.Ae.S. Conference Held in London Sept. 2–6	*Sept.*	5
Jack Frye Awarded Medal for Merit	*Feb.*	10
Lester D. Gardner, 1947 Guggenheim Medalist	*July*	7

Gifts to the Institute Collections.....*Jan.*, 9; *Feb.*, 11; *Mar.*, 13; *Apr.*, 7; *May*, 6; *June*, 6; *July*, 7; *Aug.*, 8; *Sept.*, 9; *Oct.*, 6; *Nov.*, 8; *Dec.* 8
High British Honor Accorded American Delegates in London..... *Oct.* 5
Honors Night Dinner and Annual Meeting Program..... *Jan.* 6
Paul Hovgaard Joins Piasecki Helicopter Corporation..... *May* 6
Dr. Harvard L. Hull, Associate Director of the Argonne National Laboratory..... *Feb.* 10
I.A.S. Briefs.....*Feb.*, 24; *Mar.*, 36; *Apr.*, 28; *May*, 26; *June*, 24; *July*, 28; *Aug.*, 30; *Sept.*, 28; *Oct.*, 24; *Nov.*, 18; *Dec.* 28
I.A.S. Constitution Amendments Approved at Council Meeting..... *Oct.* 7
I.A.S. Establishes First Section Outside U.S.A... *Mar.* 12
I.A.S. Meeting in Dayton; Symington Offers "New Deal"..... *Dec.* 6
I.A.S. Members View Latest Navy Air Developments at Philadelphia Naval Base Air Units.. *Aug.* 6
Captain Ide Honored..... *Jan.* 9
Impressions of the Annual Meeting of the Institute, Alexander Klemin..... *Mar.* 26
Institute Council for 1947..... *Mar.* 6
Institute Members Reorganize Firm..... *June* 6
M.I.T. Special Summer Session..... *Apr.* 7
Major Gen. Clements McMullen, Deputy Commander, Strategic Air Command..... *Mar.* 12
McDonnell Aircraft Appoints Don R. Berlin Vice-President..... *Mar.* 12
Muroc Air Base Visited by I.A.S. Members..... *Sept.* 6
New Era Note..... *Dec.* 8
Nordlinger Named Ranger Sales Director..... *Nov.* 6
Norris Elected Vice-President of Luscombe..... *Mar.* 12
Northrop Gets A.S.M.E. Honor for Flying Wing. *Sept.* 8
Officers for 1947..... *Feb.* 6
Personal Aircraft Meeting Program Takes Shape. *May* 5
Personal Plane Progress—Highlights from the Detroit Personal Aircraft Meeting, Ralph Upson *July* 18
Plan 15th Anniversary Party at Annual Summer Meeting..... *July* 5
Plans Under Way for National Propulsion Meeting..... *Feb.* 5
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Arthur E. Raymond Honored..... *July* 6
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Admiral Richardson Named V.-P., Curtiss-Wright Corp..... *Oct.* 7
S.A.I. Completes First Phase; Division Headings Determined..... *Dec.* 7
S.E.S.A. Meeting in December..... *Sept.* 8
John W. Sharp Forms New Engineering Company *May* 6
Shoults Elected National Chairman of Aircraft Industries Association Committee..... *June* 6
Sixteenth Annual Meeting Plans Include Air Transport Day..... *Dec.* 5
Sixteenth Annual Meeting Plans Stress Air-Carrier Problems..... *Nov.* 6
Soderberg Named M.I.T. Engineering Department Head..... *Aug.* 7
General Spaatz Plans Direct Contact with All Former A.A.F. Personnel..... *Jan.* 9
Sperry's Flying Lab Loaned to University of Southern California..... *Sept.* 8
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Stanley Named V.-P. Engineering of Bell Aircraft Corp..... *July* 6
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Three I.A.S. Members Elected to N.A.S.C. Steering Committee..... *July* 6
Timoshenko Awarded 1947 James Watt International Medal..... *June* 6
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"What the Customer Wants," Topic of Personal Aircraft Meeting..... *Apr.* 5
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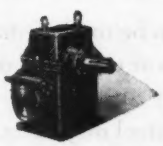

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